Curriculum details
Bachelor of Engineering Degree in Innovative Materials Engineering
(International Program)

Name of University King Mongkut's University of Technology North Bangkok (KMUTNB)
Faculty/Department Faculty of Engineering, Department of Materials and Production Technology Engineering

Section 1 General Information

1. Curriculum Name

Bachelor of Engineering in Innovative Materials Engineering (International program)

2. Degree granted and Discipline

Full name Bachelor of Engineering (Innovative Materials Engineering)
Abbreviated B.Eng. (Innovative Materials Engineering)

3. Major field of study

None

4. Total credits

141 credits

5. Type of Curriculum

5.1 Format

Bachelor's degree, four-year program

5.2 Language

All subjects are taught in English.

5.3 Admission

Any students who finished high school or have a vocational certificate or equivalent study level.

5.4 Academic cooperation

This curriculum is undertaken in conjunction with the memorandum of understanding in academic cooperation between Faculty of Engineering, King Mongkut's University of Technology North Bangkok and Institut Polytechnique de Grenoble, France.

5.5 Degree Granted

A bachelor's degree in Innovative Materials Engineering (International program) offered by KMUTNB.[1]

6. Status of Curriculum

In development

7. Policy in publishing/promoting the finalized curriculum

The final curriculum will be ready to publish by the Thai Qualifications Framework for higher education (TQF) and registered in the database of the commission for higher education (Thai Qualifications Register: TQR) as Bachelor's degree of Innovative Materials Engineering - International Program, before the academic year 2015.

8. Primary graduate opportunities

- Materials Engineer
- Metallurgical Engineer
- Manufacturing Engineer/Quality control Engineer
- Industrial Entrepreneurs
- Research assistant

[1] Students in this curriculum can choose to attend the 2+2 program to have a chance of study at another collaborating institute or university for 2 years (semesters 5 – 8). Students who complete this program are able to be granted an extra bachelor's degree from the collaborating institute or university.

9. Lecturers in the curriculum

9.1 Core lecturers

No.	Name Surname	Academic position	Education and major discipline	Institute	Year
1	Thanasak Nilsonthi	Lecturer	B.Ind.Tech. (Materials Handling Technology) M. Eng (Metallurgy Engineering) Ph.D. (Materials Engineering)	King Mongkut's Institute of Technology North Bangkok, Thailand Chulalongkorn University, Thailand University of Grenoble, France	2546 2549 2556
2	Fritz Kurt Hartung	Professor	Dipl-Ing (Mechanical Engineering; Special field in Materials Technology) Dr.-Ing (Mechanical Engineering; Special field in Materials Technology)	University of Technology Magdeburg, Germany University of Technology Magdeburg, Germany	2512 2518
3	Phutinan Uawongsuwan	Lecturer	B. Sc. (Petrochemical and polymer materials) M. Eng. (Materials Technology) Ph.D. (Advanced Fibro-Science)	Silpakorn University, Thailand King Mongkut's University of Technology Thonburi, Thailand Kyoto Institute of Technology, Japan	2543 2549 2558
4	Thanakorn Kiatbanlue	Asso. Professor	B. Sc. (Materials Science) M. Eng. (Industrial Engineering) M.A.Sc.(Operations Research Manufacturing)	Chulalongkorn University, Thailand Chulalongkorn University, Thailand University of Waterloo, Canada	2519 2521 2534
5	Vatcharachai Phumarin	Asso. Professor	B.Ind.Tech. (Production Technology) M. Eng. (Industrial Engineering)	King Mongkut's Institute of Technology North Bangkok, Thailand Chulalongkorn University, Thailand	2524 2531

9.2 Co-lecturers in the curriculum

No.	Name Surname	Academic position	Education and major discipline	Institute	Year
1	Somrerk Chandra-ambhorn	Asso. Professor	Ph.D. (Materials and Process Engineering; specialty in Electrochemistry) M.Eng. (Metallurgical Engineering) B.Eng. (Metallurgical Engineering)	Grenoble Institute of Technology, France Chulalongkorn University, Thailand Chulalongkorn University, Thailand	2549 2544 2542
2	Krittee Eiadhed	Asst. Professor	D.Eng. (Metallurgical Engineering) M.Eng. (Materials Technology) Higher Dip. Tech.(Manufacturing Technology)	Tokyo Institute of Technology, Japan King Mongkut's University of Technology Thonburi, Thailand Patumwan Institute of Technology, Thailand	2551 2546 2542
3	Piyorose Promdirek	Asst. Professor	Ph.D. (Materials and Process Engineering; specialty in Electrochemistry) DEA (Metallurgie et Materiaux) B.Eng. (Mechanical Engineering)	Chulalongkorn University, Thailand Grenoble Institute of Technology, France Institut National des Science et Technique Nuclaire, France King Mongkut's University of Technology North Bangkok, Thailand	2553 2546 2545
4	Nuttaphong Sornsuwit	Asst. Professor	D.Eng. (Mechanical and Control Engineering) M.Eng. (Mechanical and Control Engineering) B.Eng. (Mechanical and Control Engineering)	The University of Electro-Communication, Japan The University of Electro-Communication, Japan The University of Electro-Communication, Japan	2545 2542 2540
5	Wanlop Harnnarongchai	Lecturer	Ph.D. (Materials Technology) M.Eng. (Materials Technology) B.Eng. (Materials Engineering)	King Mongkut's University of Technology Thonburi, Thailand King Mongkut's University of Technology Thonburi, Thailand Kasetsart University, Thailand	2555 2550 2547
6.	Kitichai Fakphan	Lecturer	Ph.D. (Materials Science) M.Eng. (Materials Technology) B.Ind.Tech. (Production Technology)	Nagaoka University of Technology, Japan King Mongkut's University of Technology Thonburi, Thailand King Mongkut's University of Technology North Bangkok, Thailand	2556 2548 2543
7.	Tanapak Matanawin	Lecturer	Ph.D (Material Science and Engineering) M.Eng. (Materials Technology) B. Sc. (Materials Science)	University of Leeds, UK King Mongkut's University of Technology Thonburi, Thailand Chiang Mai University, Thailand	2554 2544 2540
8.	Thamrongsin Siripongsakul	Lecturer	D.Eng. (Applied Physics Engineering) M.Eng. (Applied Physics Engineering) B.Eng. (Applied Physics Engineering)	Tohoku University, Japan Tohoku University, Japan Tohoku University, Japan	2555 2544 2542

9.	Rungsinee Canyook	Lecturer	Ph.D. (Materials Engineering) B.Eng. (Materials Engineering)	Prince of Songkla University, Thailand Prince of Songkla University, Thailand	2556 2551
10.	Somkwon Watanakitpiboon	Asst. Professor	M.Econ. (Development Economics) B.Ind.Tech. (Production Technology)	National Institute of Development Administration King Mongkut's Institute of Technology North Bangkok, Thailand	2544 2538
11.	Nuansri Erbkamol	Asst. Professor	M.B.A. (Industrial Management) B.Eng. (Industrial Engineering)	University of New South Wales, Australia University of New South Wales, Australia	2521 2519
12.	Andrew Snodin	Lecturer	Ph.D., Applied Mathematics M.Math. (Mathematics)	Newcastle University, UK. Newcastle University, UK.	2551 2544
13.	Jennarong Tungtrongpairoj	Lecturer	M.Sc. (Materials and Metallurgical Engineering) B.Eng. (Metallurgical Engineering)	King Mongkut's University of Technology North Bangkok, Thailand Suranaree University of Technology, Thailand	2553 2550

9.3 Invited lecturers

No.	Name Surname	Academic position	Education and major discipline	Institute
1	Yves Wouters	Professor	Ph.D. (Process Engineering)	Institut Polytechnique de Grenoble

10. Primary venue of study

King Mongkut's University of Technology North Bangkok (KMUTNB), Thailand

11. External factors or developments to be taken into consideration in planning the curriculum

11.1 Economic situation or development

In the 21st century, new learning skills are required for making a better world. According to the partnership for 21st century skills[2], the most important skills are in creativity and innovation, which can be cultivated through associating, questioning, observing, networking and experimentation skills[3]. Furthermore, on the move towards regionalization, in particular the 2015 ASEAN Economic Community, and globalization, communication in English will be one of the essential skills for engineers. These driving forces demand the engineering curriculum to include all of these skills.

Moreover, according to the Eleventh National Economic and Social Development Plan (2012-2016), the philosophy of Sufficiency Economy has been adopted and applied to every segment of Thai society, from families and communities up to a nationwide scope. As a consequence, the resilience of the country has been strengthened through a deepening of the nation's economic, social and environmental capital. This curriculum is considered under the mentioned plan in order to harmonize with strategy in industrial development which emphasizes the increase of productivity and effectiveness in industries. The objective of this curriculum is to strengthen the fundamental factors of industrial production with the improvement of manufacturing process in terms of global standards and desired effectiveness. Moreover, innovation and creativity are key in this curriculum for supporting the industrial orientation, leading to innovative industries, environmental friendliness, and global competitiveness with international rules.

11.2 Social and cultural situation or development

On the move towards a knowledge-based society, creativity and innovation are of paramount importance. The knowledge of innovative materials engineering plays an important role to cultivate those kinds of skills within our students so that graduates from this program of study will have creativity in the innovative materials. They should also be able to effectively build and apply the knowledge in suitable and ethical direction within their professions, sustainably leading to the social and cultural development of the country.

12. Effects mentioned in no.11.1 and 11.2 on the curriculum development and their relevance to the mission of the university/institute

12.1 Curriculum improvement

A materials engineering curriculum has been taught at KMUTNB for a decade. Because of the global and regional changes mentioned in Section 11, the international curriculum in this field is then planned to launch by the year 2015. This is mainly to include and emphasize the new set of skills needed for the new coming materials engineers for the 21st century, i.e., the innovative and communication skills.

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2 www.p21.org

3 J.H. Dyer, H.B. Gregerson and C.M. Christensen, "The Innovator's DNA", *Harvard Business Review*, December 2009.

12.2 Mission of the university

KMUTNB has a mission to supply qualified graduates to society, to encourage research and academic work, to support public academic services, and to maintain national art and culture. Our philosophy is to encourage innovation in science and technology through the development of people. The present curriculum straightforwardly serves the mission of KMUTNB by aiming to cultivate materials engineers with international recognition and internationally competitive ability.

13. Relation to other curricula which are available in other departments /faculties

The curriculum of the Bachelor's Program in Materials Engineering has the relation to other curriculums as listed below

13.1 Courses in this curriculum which are available in other departments/faculties/curriculums

The present curriculum is in accordance with the requirements of the Thailand council of engineers for metallurgical engineering major students, which are not available in any other departments of KMUTNB. However, some courses, e.g., quality control and engineering economy, are also included in the present curriculum as elective subjects, even though they are also taught in other departments. These two particular electives are to improve student skills on quality control and management in engineering works.

13.2 Courses in this curriculum which students in other programs of study can register

Students in other departments/faculties can choose to attend some courses which are available in this curriculum.

13.3 Management

The department of Materials Engineering is in charge of the course and cooperating with other departments/faculties.

Section 2 Specific details of the curriculum

1. Philosophy, emphasis and objectives of the curriculum

1.1 Philosophy

To encourage innovation and creativity in materials engineering through the development of people. Innovative and English communication skills are emphasized in the curriculum.

1.2 Emphasis

This curriculum has emphasized on serving to create graduates who have academic and professional knowledge, ability in Materials Engineering and innovative skills, in order to follow and serve the industrial demand, according to National Development Plan on Higher Education issue 11 (B.S. 2555-2559), and National Development Plan on Social and Economy.

1.3 Objectives of the curriculum

1.3.1 To produce materials engineers who are academically sound with strong work ethics.

1.3.2 To produce materials engineers who are creative, innovative and have good entrepreneurship skills.

1.3.3 To produce globally accepted materials engineers who are able to communicate and work as a team.

2. Plan for development and improvement

Plan for development/revision	Strategies	Indicators
Construction of the curriculum for Bachelor of Materials Engineering which to be in accordance with Materials Engineering degree by Ministry of Education, and relating to the demand of industry.	1. Checking the variation of manpower demand in the industrial sector in order to improve the curriculum. 2. Inviting specialists in both government and private sectors in order to improve the curriculum. 3. Collaboration with the industrial sector to arrange activities and training courses. 4. Follow up and checking the curriculum continuously.	1. Overall operation report. 2. Report of exchange students. 3. Document of cooperation with industry. 4. Entrepreneurs favor the graduates with a score higher than 3.5 out of 5.
Improvement of the resources of department for supporting student study.	1. New lecturers must pass the teaching skills training. 2. Support lecturers to go abroad for training and studying.	1. Documents of overall operation. 2. Documents of scholarship.

Section 3 Education system, Operation and Structure of the curriculum

1. Education system

1.1 System

The education system is divided into two semesters in one year, and additionally a summer study period. One semester has a period of study for not less than 15 weeks. The credit accreditation is based on the curriculum standard criteria of bachelor's degree in 2005 of the Ministry of Education according to the regulations of King Mongkut's University of Technology North Bangkok that with bachelor degree in 2009 and revised version in 2011.

1.2 Summer education system

None

Caution: The full-time internship in the industry will be organized regularly during the summer study period of the 3rd year students and should be for a total of 240 hours before the 4th year. Some courses in the curriculum may also be available during the summer period which will be announced by the curriculum committee.

1.3 The credit transfer policy

None

Caution: There is a system whereby students can use credits gained in other institutes in order to transfer into our program of study. This policy is also being developed to meet collaboration between universities or institutes.

2. Curriculum operation

2.1 Dates of operation

First semester	August – December
Second semester	January – May
Summer period	June – July

2.2 Entry requirements

Having graduated with a vocational certificate in the field of industrial technology or a high school certificate (or equivalent certificate from educational institutions certified by the Ministry of Education) and having one of the following:

2.2.1 Qualifications according to the admission regulations of the Office of the Higher Education Commission, or the university entrance examination, and other extra regulations issued by KMUTNB 2009 and revised in 2011.

2.2.2 High school level test scores, such as SAT scores or ICGSE scores. The subjects and scores must be in accordance with the annual announcement of the faculty of engineering, KMUTNB.

2.2.3 English efficiency test scores, such as CU-TEP, TU-GET, TOEFL, TOEFL-ibt, IELTS , K-STEP test. The scores must be in accordance with the annual announcement of the faculty of engineering, KMUTNB.

.3 Requirements for graduation

2.3.1 Requirements for graduation are on accordance with the regulations of KMUTNB

2.3.2 Students in this curriculum must have the scores of English language proficiency, such as CU-TEP, TU-GET, TOEFL, TOEFL-ibt, IELTS, K-STEP, of which the scores are equivalently not less than TOEFL-ibt score of 52.

2.3.3 Students in this curriculum must have passed an industrial training program of which the period is not less than 240 hours. The details of this program can be referred to part 4, configuration of the industrial internship of this section.

2.4 Potential problems which new students may encounter when they start the program

Students should have satisfactory grades in English, as all lectures, course materials documents will be in English. Therefore students in this program who are not native English speakers must get good scores from standardized test in English proficiency. Students should reach the required the level of English proficiency by the end of the first year.

2.5 Strategies to solve the issue/limitations of student in 2.4

The strategy to resolve problems of students who do not pass the Basic English and mathematics is set by arranging training courses in English, science and mathematics during the vacation before the start of each semester.

2.6 Plans for admission and graduates during 5 years

Class level		Number of enrolled students (person)				
		2015	2016	2017	2018	2019
Bachelor degree	1st year	40	40	40	40	40
	2nd year		40	40	40	40
	3rd year			40	40	40
	4th year				40	40
	Total	40	80	120	160	160
Expected to graduate						40

2.7 Budget plan

2.7.1 Revenue budget (Unit : Baht)

Detail	Budget year (Baht)				
	2015	2016	2017	2018	2019
Government grants	-	-	-	-	-
Education fee	3,200,000	6,400,000	9,600,000	12,800,000	12,800,000
Total	3,200,000	6,400,000	9,600,000	12,800,000	12,800,000

2.7.2 Expenditure budget (Unit : Baht)

Detail	Budget year (Baht)				
	2015	2016	2017	2018	2019
a. Operation budget					
Salary	15,438,890	16,210,834	17,021,376	17,872,445	18,766,067
Compensation	1,497,220	1,572,081	1,650,685	1,733,219	1,819,880
Expenses	40,000	40,000	40,000	40,000	40,000
Material cost	650,000	715,000	786,500	865,150	951,665

Subsidies	59,700	65,670	72,237	79,460	87,406
Miscellaneous	0	0	0	0	0
Total (a)	17,685,810	18,603,585	19,570,798	20,590,274	21,665,018
b. Investment budget					
Equipment cost	300,000	315,000	330,750	347,287	364,651
Land cost	0	0	0	0	0
Building cost	0	0	0	0	0
Total (b)	300,000	315,000	330,750	347,287	364,651
Total (a) + (b)	17,985,810	18,918,585	19,901,548	20,937,561	120,029,669
Number of students	40	80	120	160	160
Year Expenses per one student	(449,645/5 = 89,929)				

2.8 Education system

Teaching will be done in accordance with the regulations of King Mongkut's University of Technology North Bangkok pertaining to bachelor degrees (2009, revised in 2011).

2.9 Transfer of credits, courses and registration between other universities

Credits can be transferred, according to the regulations of King Mongkut's University of Technology North Bangkok.

3. Curriculum structure and lecturers

3.1 Curriculum

3.1.1 Number of credits for the overall curriculum	141	credits
3.1.2 Structure of the curriculum		
3.1.2.1 General education	32	credits
a. Linguistic subjects	18	credits
b. Social and humanities subjects	6	credits
c. Science and mathematics	6	credits
d. Physical education	2	credits
3.1.2.2 Engineering education	103	credits
a. Science courses for engineering	24	credits
b. Fundamental Engineering courses	25	credits
c. Innovative materials engineering courses	54	credits
- Compulsory courses	48	credits
- Elective courses	6	credits
3.1.2.3 Free elective subjects	6	credits

3.1.3 Lists of subjects

3.1.3.1 General education	30	Credits
a. Linguistic subjects		
- Compulsory subjects	6	Credits
080103001 English I		3(3-0-6)[4]
080103002 English II		3(3-0-6)
- Elective subjects	12	Credits
Complete at least 9 credits of the following courses.		
080103012 Reading I		3(3-0-6)
080103016 English conversation I		3(3-0-6)
080103017 English conversation II		3(3-0-6)
080103018 English for work		3(3-0-6)
Other subjects can be selected from a list of general education available at KMUTNB.		
b. Social and humanities subjects		
- Elective Courses	6	Credits
Complete at least 7 credits of the following courses.		
080203901 Man and Society		3(3-0-6)
080203903 Social, Economics and Politics Dimension		3(3-0-6)
080203904 Law for Everyday Life		3(3-0-6)
080203905 Economy and Everyday Life		3(3-0-6)
080203906 Business and Everyday Life		3(3-0-6)
080303201 Effective Speech		3(3-0-6)
080303301 Art Appreciation		3(3-0-6)
080303601 Human Relations		3(3-0-6)
080303606 Systematic and Creative Thinking		3(3-0-6)
Other subjects can be selected from a list of general education available from the department of social sciences and humanities at KMUTNB.		
c. Science and Mathematics		
- Elective Courses	6	Credits
Complete at least 6 credits of the following courses.		
010123801 Computer in Everyday Life		3(3-0-6)
040113065 Chemistry in Everyday Life		3(3-0-6)
040203110 General Mathematics		3(3-0-6)
040433002 Food in Daily Life		3(3-0-6)
040503001 Statistics in Everyday Life		3(3-0-6)
Other subjects can be selected from a list of general education available from the department of Science and Mathematics at KMUTNB.		

[4] 3(3-0-6) means that this subject takes 3 credits. It requires 3 hours of lecture, 0 hour of laboratory, and 6 hours of private study for one week.

d. Physical education	2	Credits
Complete at least 2 credits of the following courses.		
080303501 Basketball		1(0-2-1)
080303502 Volleyball		1(0-2-1)
080303503 Badminton		1(0-2-1)
080303504 Dancing		1(0-2-1)
080303505 Table Tennis		1(0-2-1)
Other subjects can be selected from a list of general education available from the department of physical education at KMUTNB		

3.1.3.2 Engineering education	103	Credits
a. Science courses for engineering	24	Credits
040113001 Chemistry for Engineers		3(3-0-6)
040113002 Chemistry Laboratory for Engineers		1(0-3-1)
040293111 Engineering Mathematics and computation I		3(3-0-6)
040293112 Engineering Mathematics and computation II		3(3-0-6)
010633007 Mathematical Methods for Materials Engineering		3(3-0-6)
040313005 Physics I		3(3-0-6)
040313006 Physics Laboratory I		1(0-2-1)
040313007 Physics II		3(3-0-6)
040313008 Physics Laboratory II		1(0-2-1)
040503011 Statistics for Engineers and Scientists		3(3-0-6)

b. Fundamental Engineering courses	25	credits
010113851 Basic Electrical Engineering		3(3-0-6)
010113852 Basic Electrical Laboratory		1(0-3-1)
010403096 Computer Programming		3(2-2-5)
010403098 Engineering Materials		3(3-0-6)
010403099 Engineering Drawing		3(2-2-5)
010633001 Engineering Mechanics		3(3-0-6)
010633002 Thermodynamics of Materials		3(3-0-6)
010633003 Mechanics of Materials		3(3-0-6)
010633004 Transport Phenomena in Materials Processing		3(3-0-6)

c. Innovative materials engineering courses	54	credits
- Compulsory courses	48	credits
010633101 Fundamentals in Materials I		3(3-0-6)
010633102 Fundamentals in Materials II		3(3-0-6)
010633103 Laboratory on Metallurgy		1(0-2-1)
010633104 Mechanical Behavior of Materials		3(3-0-6)
010633105 Laboratory on Materials Testing		1(0-2-1)
010633106 Materials Extraction and Recycling		3(3-0-6)
010633107 Laboratory on Materials Extraction and Recycling		1(0-2-1)
010633108 Environmental Degradation and Durability of Materials		3(3-0-6)
010633109 Failure Analysis of Materials		3(3-0-6)
010633110 Materials Characterization		3(3-0-6)

010633111 Materials Forming 3(3-0-6)

010633112 Laboratory on Materials Forming	1(0-2-1)
010633406 Electronic Properties of Materials	3(3-0-6)
010633513 Principle of Innovation in Materials Engineering	3(2-2-5)
010633514 Thinking-skills and Creativity Development for Materials Innovators	3(2-2-5)
010633515 Seminar on Innovative Materials Engineering	1(0-2-1)
010633516 Innovative Conceptual Engineering Design	3(2-2-5)
010633517 Materials Selection and Innovative Design	3(2-2-5)
010633518 Innovative Materials Engineering Project I	1(0-2-1)
010633519 Innovative Materials Engineering Project II	3(0-6-3)

- Elective topics in materials engineering 6 credits

010633115 Surface Engineering	3(3-0-6)
010633116 Non-Destructive Testing	3(3-0-6)
010633119 Special Topic in Materials Engineering I	3(3-0-6)
010633120 Special Topic in Materials Engineering II	3(3-0-6)
010633201 Ferrous and Non-Ferrous Metallurgy	3(3-0-6)
010633202 Ferrous and Non-Ferrous Metallurgy Laboratory	1(0-2-1)
010633205 Foundry Engineering	3(2-2-5)
010633207 Welding Metallurgy	3(3-0-6)
010633211 Heat Treatment of Metals	3(2-2-5)
010633213 Powder Metallurgy	3(3-0-6)
010633216 Stainless Steel	3(3-0-6)
010633217 High-Temperature Materials	3(3-0-6)
010633218 Aluminium Processing Technology	3(3-0-6)
010633219 High Temperature Corrosion and Protection of Metals	3(3-0-6)
010633222 Welding Procedure Qualification for Pressure Vessel Equipment	3(3-0-6)
010633224 Rolling Technology	3(3-0-6)
010633225 Fracture Mechanics of Materials	3(3-0-6)
010633226 Iron and Steel	3(3-0-6)
010633301 Nanopolymer	3(2-2-5)
010633302 Polymer Processing and Rheology	3(3-0-6)
010633303 Polymer Matrix Composite Materials	3(2-2-5)
010633401 Introduction to Nanotechnology for Materials Engineering	3(3-0-6)
010633404 Micro and Nano Electromechanical Systems	3(3-0-6)
010633503 Computer Aided Design	3(3-0-6)
010633520 Biocompatible Materials	3(3-0-6)
010633613 Quality Control and Management	3(3-0-6)
010633614 Engineering Economy	3(3-0-6)

3.1.2.3 Free elective subjects 6 credits

Completing at least 6 credits from any subjects available at KMUTNB.

3.1.4 Study Plan

3.1.4.1 An example of a four year program of study

Year 1 Semester 1

040293111	Engineering Mathematics and Computation I	3(3-0-6)
040313005	Physics I	3(3-0-6)
040313006	Physics Laboratory I	1(0-2-1)
040113001	Chemistry for Engineers	3(3-0-6)
040113002	Chemistry Laboratory for Engineers	1(0-3-1)
010633513	Principle of Innovation in Materials Engineering	3(3-0-6)
080103001	English I	3(3-0-6)
		Total 17(x-x-x)

Year 1 Semester 2

040293112	Engineering Mathematics and Computation II	3(3-0-6)
040313007	Physics II	3(3-0-6)
040313008	Physics Laboratory II	1(0-2-1)
010633002	Thermodynamics of Materials	3(3-0-6)
010403098	Engineering Materials	3(3-0-6)
010633514	Thinking-skills and Creativity Development for Materials Innovators	3(2-2-5)
080103002	English II	3(3-0-6)
		Total 19(x-x-x)

Year 2 Semester 1

010633007	Mathematical Methods for Materials Engineering	3(3-0-6)
010403096	Computer Programming	3(2-2-5)
010633001	Engineering Mechanics	3(3-0-6)
010633101	Fundamentals in Materials I	3(3-0-6)
010633103	Laboratory on Metallurgy	1(0-2-1)
010403099	Engineering Drawing	3(2-2-5)
080xxxxxx	Language Elective Course	3(x-x-x)
		Total 19(x-x-x)

Year 2 Semester 2

040503011	Statistics for Engineers and Scientists	3(3-0-6)
010113851	Basic Electrical Engineering	3(3-0-6)
010113852	Basic Electrical Laboratory	1(0-2-1)
010633003	Mechanics of Materials	3(3-0-6)
010633102	Fundamentals of Materials II	3(3-0-6)
010633106	Materials Extraction and Recycling	3(3-0-6)
010633107	Laboratory on Materials Extraction and Recycling	1(0-2-1)
080xxxxxx	Language Elective Course	3(x-x-x)
		Total 20(x-x-x)

Year 3 Semester 1

010633104	Mechanical Behavior of Materials	3(3-0-6)
010633105	Laboratory on Materials Testing	1(0-2-1)
010633406	Electronic Property of Materials	3(3-0-6)
010633004	Transport Phenomena in Materials Processing	3(3-0-6)
010633516	Innovative Conceptual Engineering Design	3(2-2-5)
080xxxxxx	Language Elective Course	3(x-x-x)
080xxxxxx	Physical Education Elective Course	1(x-x-x)
	Total	17(x-x-x)

Year 3 Semester 2

010633110	Materials Characterization	3(3-0-6)
010633111	Materials Forming	3(3-0-6)
010633112	Laboratory on Materials Forming	1(0-2-1)
010633108	Environmental Degradation and Durability of Materials	3(3-0-6)
010633517	Materials Selection and Innovative Design	3(2-2-5)
010633515	Seminar on Innovative Materials Engineering	1(0-2-1)
080xxxxxx	Social Sciences and Humanities Elective Course	3(x-x-x)
080xxxxxx	Physical Education Elective Course	1(x-x-x)
	Total	18(x-x-x)

Out-campus program

	Industrial Training	0(0-240-0)
	Total	0(0-240-0)

Year 4 Semester 1

xxxxxxxxx	Free Elective	3(3-0-6)
xxxxxxxxx	Science and Mathematics Elective Course	3(3-0-6)
010633109	Failure Analysis of Materials	3(3-0-6)
010633518	Innovative Material Engineering Project I	1(0-2-1)
010xxxxxx	Technical Elective Course	3(x-x-x)
080xxxxxx	Language Elective Course	3(x-x-x)
		Total 16(x-x-x)

Year 4 Semester 2

xxxxxxxxx	Free Elective	3(3-0-6)
xxxxxxxxx	Science and Mathematics Elective Course	3(3-0-6)
010xxxxxx	Technical Elective Course	3(x-x-x)
010633519	Innovative Material Engineering Project II	3(0-3-6)
080xxxxxx	SocialSciences and Humanities Elective Course	3(x-x-x)
		Total 15(x-x-x)

3.1.4.2 An example of 2 year study plan at KMUTNB for the 2 + 2 program (Collaboration with another institute or university)

1st year, semester 1

Course Code	Course Name	Credit (Class-Lab-Self Study)
040203151	Engineering Mathematics and computation I	3(3-0-6)
040313005	Physics I	3(3-0-6)
040313006	Physics Laboratory I	1(0-2-1)
040113061	Chemistry for engineers	3(3-0-6)
040113062	Chemistry Laboratory for engineers	1(0-2-1)
0101xxxxx	(Elective from Gen. Sci. and Math. 1)	3(3-0-6)
080103001	English I	3(3-0-6)
0802xxxxx	(Elective from Social and Humanities 1)	3(3-0-6)
0803xxxxx	(Elective from Physical Education 1)	1(0-2-1)
		Total 21(17-8-38)

1st year, semester 2

040203152	Engineering Mathematics and computation II	3(3-0-6)
040313007	Physics II	3(3-0-6)
040313008	Physics Laboratory II	1(0-2-1)
0402xxxxx	(Elective from Gen. Sci. and Math. 2)	3(3-0-6)
010403098	Engineering Materials	3(3-0-6)
010623619	Thinking-skills and Creativity Development for Materials Innovators	3(2-2-5)
080103002	English II	3(3-0-6)
0803xxxxx	(Elective from Social and Humanities 3)	1(0-2-1)
0803xxxxx	(Elective from Physical Education 2)	1(0-2-1)
		Total 21(17-8-38)

Summer period study (1st year)

010623618	Principle of innovation in materials engineering	3(2-2-5)
010623619	(Elective from Linguistic subjects 3)	3(3-0-6)
		Total 6(5-2-11)

2nd year, semester 3

Course Code	Course Name	Credit (Class-Lab-Self Study)
010623651	Mathematical methods for materials engineering	3(3-0-6)
010403096	Computer Programming	3(2-2-5)
010623601	Engineering Mechanics	3(3-0-6)
010623605	Fundamentals of Materials I	3(3-0-6)
010623614	Laboratory on Metallurgy	1(0-2-1)
010403099	Engineering Drawing	3(2-2-5)
0801xxxxx	(Elective from Linguistic subjects 1)	3(3-0-6)
0802xxxxx	(Elective of Social and humanities 2)	3(3-0-6)
		Total 22(19-6-41)

2nd year, semester 4

040503011	Statistics for engineers and scientists	3(3-0-6)
010113851	Basic Electrical Engineering	3(3-0-6)
010113852	Basic Electrical Laboratory	1(0-2-1)
010623603	Mechanics of Materials	3(3-0-6)
010623606	Fundamentals of Materials II	3(3-0-6)
010623612	Materials extraction and recycling	3(3-0-6)
010623617	Laboratory on Materials extraction and recycling	1(0-2-1)
0801xxxxx	(Elective of Linguistic subjects 2)	3(3-0-6)
		Total 20(18-4-38)

3.1.5 Course description

010113851 Basic Electrical Engineering 3(3-0-6)

Pre-requisite : 040313007 Physics II

Units in electrical measurement, resistor, inductor, capacitor, analysis of a static state ofa direct current circuit, analysis of a one-phase and three-phase of alternative current circuits, calculation and reduction of electrical power factors in a fundamental magnetic circuit, transformer, and its usage, method of power transmission, some basic electrical instruments.

010113852 Basic Electrical Laboratory 1(0-3-1)

Pre-requisite : 010113851 Basic Electrical Engineering

Usage of basic electrical instruments and electrical experiments supporting basic electrical engineering subject.

010123801 Computer in Everyday Life 3(3-0-6)

Pre-requisite : None

Usage of package programs, word processing, spreadsheets; Familiarization with computer; Usage of operating systems, Windows and Unix; Usage of internet and management of internet security, morals, safety in health and quality of life; Basic programming and careers related to computers.

010403096 Computer Programming 3(2-2-5)

Pre-requisite : None

Computer concepts; computer components; hardware and software operation interaction; EDP concepts; program design and development methodology; concept of high-level language programming, computer based problem-solving.

010403098 Engineering Materials 3(3-0-6)

Pre-requisite : None

Metal and introduction to metallurgy, phase equilibrium diagram, micro and macro structure of metal, steel production and its properties, stainless steels, cast irons and heat treatment to improve the properties of cast irons, non-ferrous metals and properties, polymers, composites, concrete, asphalt, and wood, basic concept of destructive and non-destructive tests.

010403099 Engineering Drawing 3(2-2-5)

Pre-requisite : None

Specifications and standardsof drawings,freehand sketches, orthographic projection, geometric figures, dimensioning geometry and referential positioning,3D images, sections, and assembly drawings.

010633001 Engineering Mechanics 3(3-0-6)

Pre-requisite : 040203151 Engineering Mathematics and Computation I
040313005 Physics I

Force systems, resultant, equilibrium, fluid statics, kinematics and kinetics of particles and rigid bodies, Newton’s second law of motion, work and energy, impulse and momentum.

010633002 Thermodynamics of Materials 3(3-0-6)

Pre-requisite : 040313005 Physics I or co-requisite

Thermodynamic potential and equilibrium condition, Maxwell's relations, heat capacity and thermodynamics of simple reactions, equilibrium of one component and multi-phase system, construction of a binary phase diagram, elementary tertiary phase diagram, thermodynamics of reacting system consisting of multi-components and multi-phases, reactions containing gaseous and condensed phases, reactions containing multi-components in condensed solution, electrochemistry, statistical thermodynamic aspect to explain the relevant macroscopic phenomena.

010633003 Mechanics of Materials 3(3-0-6)

Pre-requisite : 010633004 Engineering Mechanics or co-requisite

Forces and stress, strain, relationship between stresses and strains, stresses in beams, shear force and bending moment diagrams, deflection of beams, torsion, buckling of columns, transformation of stresses and strains, Principle of stress and strain, Mohr's circle and stresses under combined loading, failure criterion.

010633004 Transport Phenomena in Materials Processing 3(3-0-6)

Pre-requisite : 040313005 Physics I

Laminar flow and turbulent flow, Newton's viscosity law, mass-balance equation, momentum-balance equation, similitude and dimensional analysis, flow in pipe, conduction, convection and radiation, energy-balance equation, Fick's law of diffusion, analytical and numerical methods for applications in materials processing, equipment associated with transport phenomena in materials processing.

010633007 Mathematical Methods for Materials Engineering 3(3-0-6)

Pre-requisite : 040293112 Engineering Mathematics and Computation II

Ordinary differential equations. Fourier series and integral transform. Solutions of partial differential equation using the technique of separation of variables. Solutions of partial differential equation using the transform method. Numerical differentiation and integration. Solving of differential equations by numerical methods. Vector and tensor analyses in mathematical modeling of transport phenomena. Application to the problems in transport phenomena, kinetics and mechanical behavior of materials.

010633101 Fundamentals in Materials I 3(3-0-6)

Pre-requisite : None

Crystal structure, crystal defects, crystal interfaces and microstructure, crystal structures of metals and ceramics, solid solution and compound, phase equilibrium diagrams of metals, alloys and ceramics, solidification, diffusion, principle of solid-state phase transformation, plastic deformation in crystalline solid, recovery, recrystallization and grain growth, strengthening mechanism and microstructural control, mechanical properties of metals and ceramics.

010633102 Fundamentals in Materials II 3(3-0-6)

Pre-requisite : None

Type of polymers and classification, polymerization techniques, structure of polymers, conventional and engineering polymers, copolymer and polymer blends, classification of polymer composites, manufacturing of polymers and polymer composites, properties and applications of polymers and polymer composites, rubber technology.

010633103 Laboratory on Metallurgy 1(0-2-1)

Pre-requisite : 010633101 Fundamentals in Materials I or co-requisite

Laboratories in metallurgy with the content and practice corresponding to 010633101 Fundamentals of Materials I.

010633104 Mechanical Behavior of Materials 3(3-0-6)

Pre-requisite : None

Stress-strain relationship of metals, ceramics and polymer, mechanical behavior of composite materials, effect of structural arrangement of materials on their mechanical properties, elastic and plastic behaviors of materials, dislocation theory, mechanical testing, i.e. tensile, hardness, torsion, impact, fatigue and creep testing, fracture mechanics, failure of materials.

010633105 Laboratory on Materials Testing 1(0-2-1)

Pre-requisite : None

Laboratories in mechanical testing of materials with the fundamental mechanical testing, tensile, hardness, torsion, impact, fatigue and creep testing. Non-destructive testing. Innovative design of materials using mechanical testing with project-based study.

010633106 Materials Extraction and Recycling 3(3-0-6)

Pre-requisite : None

Thermodynamics of aqueous solutions, kinetics of leaching and precipitation, solvent extraction and ion exchange, principle of hydrometallurgy. electrochemistry of aqueous solutions, current and energy efficiency, principle of pyrometallurgy, calcination, roasting and metal reduction, extraction of ferrous and non-ferrous metals, analytical methods in electrochemistry, application in electrochemical engineering.

010633107 Laboratory on Materials Extraction and Recycling 1(0-2-1)

Pre-requisite : 010633106 Materials Extraction and Recycling or co-requisite

Laboratories in materials electrochemistry with the content and practice corresponding to 010633106 Extraction and recycling of materials, galvanic corrosion, electrolytic cells, polarisation analysis, anodic and cathodic corrosion protection, innovative design of materials concerned with chemical metallurgy laboratory with project-based study.

010633108 Environmental Degradation and Durability of Materials 3(3-0-6)

Pre-requisite : 040113001 Chemistry for Engineers

Industrial and Innovative contexts in environmental degradation and durability of materials, chemical and electrochemical thermodynamics of materials degradation, Gibbs free energy of chemical degradation, Ellingham diagram, Nernst equation, Pourbaix diagram, determination of corrosion rate, kinetics and transport phenomena in chemical degradation of materials, electrochemical methods in the corrosion study potentiodynamic and electrochemical impedance methods, appearances, causes and remedies of corrosion in various forms, such as in the forms of uniform, crevice, pitting, intergranular, selective, erosion, stress and high-temperature corrosion, corrosion of engineering alloys, chemical degradation of ceramics and polymers, effects of environments on chemical degradation and durability of materials, methods to prevent the chemical degradation of materials, including the electrochemical one, case studies of corrosion and protection of materials in industries, as well as innovative materials to combat the corrosion.

010633109 Failure Analysis of Materials 3(3-0-6)

Pre-requisite : 010633104 Mechanical Behavior of Materials and
010633108 Environmental Degradation and Durability of Materials

Failure analysis tools focusing on the practical aspect, mechanical fracture, failure due to corrosion, failure due to wear, failure due to thermal processes, case studies in failure analysis, prevention of materials.

010633110 Materials Characterization 3(3-0-6)

Pre-requisite : None

Basic chemical analyses, spectroscopy techniques. x-ray characterizing techniques and electron spectroscopy (scanning electron microscopy and transmission electron microscope), quantification of phase and grain size using optical microscope, analyses of phase transformation using thermal and dilatometric methods, thermal analysis such as TGA and DSC, surface analysis using atomic force microscopy.

010633111 Materials Forming 3(3-0-6)

Pre-requisite : None

Theory and modern development of foundry processes, gating and riser design, pattern design, finishing and inspection of castings, casting design, theory of mechanical forming processes of metals i.e. rolling, forging, extrusion, drawing and sheet metal forming, source and elimination of defects, forming processes of other materials such as polymers and ceramics.

010633112 Laboratory on Materials Forming 1(0-2-1)

Pre-requisite : 010633111 Materials Forming or co-requisite

Laboratories on materials forming with the content and practice corresponding to 010633111 Materials Forming, innovative design of materials concerned with metal forming laboratory with project-based study.

010633115 Surface Engineering 3(3-0-6)

Surface Engineering

Surface preparation and analyze before coating, case hardening by various methods to enhance hardness and wear, carburizing, nitriding, chemical and physical vapor deposition, thermal spray, ion implantation, wear phenomena.

010633116 Non-Destructive Testing
3(3-0-6)

Pre-requisite : None

Various techniques in non-destructive testing, e.g. those using liquid dye penetrant, eddy current, magnetic powders, ultrasonic wave, and radioactive imaging. Comparison and application of the non-destructive testing methods.

010633119 Special Topic in Materials Engineering I 3(3-0-6)

Pre-requisite : None

Study in the interesting topics in materials engineering.

010633120 Special Topic in Materials Engineering II 3(3-0-6)

Pre-requisite : None

Study in the interesting topics in materials engineering.

010633201 Ferrous and Non-Ferrous Metallurgy 3(3-0-6)

Pre-requisite : None

Iron and Steel making processes include casting, hot rolling and cold rolling. Phase transformation of iron-carbon system and isothermal transformation. Structure and Properties of Carbon steel, Low alloy steel, Cast iron, stainless steels and tool steel. Basic principles in heat treatment of Steel and Cast iron. Production process, structure and property of Copper alloys, Aluminium alloys, Magnesium alloys, Zinc alloy, Nickel alloys and Titanium alloy. Relationship between chemical composition, microstructure, heat treatment process and property of Non-ferrous metals.

010633202 Ferrous and Non-Ferrous Metallurgy Laboratory 1(0-2-1)

Pre-requisite : 010633201 Ferrous and Non-Ferrous Metallurgy

Laboratories in Ferrous and Non-ferrous metallurgy with the content and practice corresponding to 010633201 Ferrous and Non-Ferrous Metallurgy Laboratory.

010633205 Foundry Engineering 3(3-0-6)

Pre-requisite : None

Basic casting. Advanced casting. Pattern. Cavity. Core and its materials. Sand casting box and binders. Testing and control of properties of sand. Refractory. Casting furnace. Gating and riser systems. Solidification. Ferrous and non-ferrous casting. Casting design. Defects and remedies of casted materials. Safety in casting shop. Casting technology of cast metals, copper, copper alloyed with aluminium, aluminium alloyed with magnesium, magnesium alloyed with zinc, and zinc alloys. Low pressure casting process. High pressure casting process. Compression casting process. Semi-solid casting process.

010633207 Welding Metallurgy 3(3-0-6)

Pre-requisite : None

Methods of welding. Soldering. Brazing. Solid state and fusion welding. Effect of welding parameters on structure and properties of metals. Welding metallurgy of ferritic steels, austenitic steels, and nonferrous metals. Behaviour of welded metals used in service.

010633211 Heat Treatment of Metals 3(3-0-6)

Pre-requisite : None

Annealing. Normalising. Hardening. Tempering. Controlling of atmospheres in furnace. Case hardening by carburizing and nitriding. Heat treatment of tool steels, special steels, cast iron, and non-ferrous metals.

010633213 Powder Metallurgy 3(3-0-6)

Pre-requisite : None

Metallurgy of powders. Production of powders by mechanical and chemical methods, as well as atomisation. Characterization of powders. Forming from powders and production of densed work pieces from powders. Methods to improve the properties of work piece. Microstructure and mechanical properties of work pieces made from powder metallurgical process. Application of metallic powders and work pieces made from powder metallurgical process.

010633216 Stainless Steels 3(3-0-6)

Pre-requisite : None

Effects of alloying elements on structure and properties of stainless steels. Microstructure, physical properties, and mechanical properties of stainless steels. Passive film. Various groups of stainless steels, i.e. ferritic, martensitic, austenitic, duplex and precipitation-hardened stainless steels. Standards and criteria for the application of stainless steels in various works.

010633217 High-Temperature Materials 3(3-0-6)

Pre-requisite : None

Nickel-based alloys, nickel-iron based alloys, cobalt-based alloys, other metal alloys used at high temperature service, mechanical properties at high temperature, reaction and transformation of materials in environmental media at high temperature, creep mechanism, diffusion of vacancies, movement of line defects and grain boundary, materials selection for high temperature application, coating used for high temperature applications.

010633218 Aluminium Processing Technology 3(3-0-6)

Pre-requisite : None

Classification of wrought and cast aluminium. Effects of alloying elements. Changing in forming technology. Various types of aluminium. Casting, forging, rolling, welding, and strengthening of aluminium.

010633219 High Temperature Corrosion and Protection of Metals 3(3-0-6)

Pre-requisite : 010633001 Thermodynamics of Materials

Industrial and innovative contexts of the high temperature corrosion. Characterizing tools in the study of high temperature corrosion. Thermodynamics of high temperature corrosion. Defect chemistry. Kinetics and transport phenomena in high temperature corrosion processes. Wagner's theory on oxidation. Mechanical properties of scale-metal interface. High temperature corrosion of metals and alloys. High temperature corrosion in various atmospheres, e.g., those containing carbon, nitrogen, sulphur, halogen and water vapour. High temperature corrosion by ash/salt deposit, molten salt and molten metals. High temperature corrosion protection. Case studies in high temperature corrosion and protection of materials in industries, as well as innovative materials to combat the high temperature corrosion.

010633222 Welding Procedure Qualification for Pressure Vessel Equipment 3(3-0-6)

Pre-requisite : None

Preparation of welding procedure qualification documents for the pressure vessel equipment according to American Society of Mechanical Engineering (ASME) such as welding procedure specification (WPS), procedure qualification record (PQR), welding performance qualification (WPQ). Consisting of materials properties, welding process, general requirement of welding design, welding data, testing standard of welding specimen.

010633224 Rolling Technology 3(3-0-6)

Pre-requisite : 010633104 Mechanical Behavior of Materials

Sheet metal forming processes: hot rolling process, cold rolling process, pickling and oiling process and hot dip galvanizing (HDG) process, deformation behavior and strengthening mechanism in sheet metals during rolling process and the applications of low carbon steel grade.

010633225 Fracture Mechanics of Materials 3(3-0-6)

Pre-requisite : 010633002Mechanics of Materials or co-requisite

Introduction to the mechanics of fracture of linear and nonlinear materials. Crack stress and deformation fields, stress intensity factors, crack tip plastic zone, fracture toughness testing, energy release rate, J-integral. Fatigue failure, subcritical crack growth, stress/life and damage-tolerant design approaches. Creep deformation.

010633226 Iron and Steel 3(3-0-6)

Characteristics and microstructures of iron and steel, appropriate design, selection and application of iron and steel making processes, production process of blast furnace (BF) and electric arc furnace (EAF), ladle and secondary steel refining processes, continuous casting processes.

010633301 Nanopolymer 3(2-2-5)

Pre-requisite : None

Fundamental of nanopolymer. Structure and properties of nanopolymer. Synthesis and formation of nanopolymer. Self-assembly of nanopolymer. Nanopolymer hybrid with organic/inorganic particles. Characterization techniques of nanopolymer. Applications of nanopolymer.

010633302 Polymer Processing and Rheology 3(3-0-6)

Pre-requisite : 010633102 Fundamentals in Materials II

Introduction to rheology and classification of fluids. Viscoelastic behavior of polymeric system. Conventional injection molding processes and troubleshooting. Innovative injection molding processes. Extrusion and related processes. Compression molding. Melt spinning. Calendering. Vacuum forming. Rotational molding. Computer-aided-engineering (CAE) technology in polymer processing.

010633303 Polymer Matrix Composite Materials 3(2-2-5)

Pre-requisite : None

Classification and structure of polymer matrix composite (PMC) materials. Engineering properties of PMC. Manufacturing process and mechanical testing of PMC. The applications of PMC in engineering.

010633401 Introduction to Nanotechnology for Materials Engineering 3(3-0-6)

Pre-requisite : None

The fundamental of nanotechnology for materials engineering. Overview of physical and chemistry for nanomaterials. Synthesis and fabrication of nanomaterials. Characterization techniques of nanomaterials. The applications of nanomaterials in commercial products.

010633404 Micro and Nano Electromechanical Systems 3(3-0-6)

Pre-requisite : None

Micro/nano materials and devices. Micro/nano scale fabrication and manufacturing processes. Micro/nano sensors and actuators. Device mechanism and assembly technology. MEMS and NEMS applications and innovations.

010633406 Electronic Properties of Materials 3(3-0-6)

Pre-requisite : 010113851 Basic Electrical Engineer

Introduction of electronic materials-semiconductors, optic, magnetic and dielectric materials, transport phenomena of electrons and holes in semiconductors along with semiconductor devices such as PN junctions, transistors, photovoltaics, laser and so on. Light in solids and photonic devices, magnetic phenomena in materials and magnetic devices such as disk drive, motor and transformer, dielectric materials and devices, such as memory devices, materials selection for among electronic materials.

010633503 Computer Aided Design 3(3-0-6)

Pre-requisite : None

Principles of computer aided design to create three-dimensional modeling based on any of the modeling technique, i.e. solid modeling, surface modeling and shell modeling; geometric constraint; sketching, dimensioning and editing; creation of orthogonal projection, perspective, two- and three-dimensional drawings.

010633513 Principles of Innovation in Materials Engineering 3(2-2-5)

Pre-requisite : None

Definition of innovation, sources of innovative opportunities, theory of disruptive technology, innovator's dilemma and solution in metals and materials industries, innovator's DNA and creative personalities, discovery quotient, case studies of iconoclasts as well as materials technological innovators.

010633514 Thinking-skills and Creativity Development for Materials Innovators 3(2-2-5)

Pre-requisite : None

Description of Thinking, thinking skills, comparative thinking, analytical thinking, critical thinking, synthesis-type thinking, conceptual thinking, applicative thinking, strategic thinking, futuristic thinking, integrative thinking, logical thinking, scientific thinking, parallel thinking, lateral thinking, creative thinking, etc., associational thinking for innovative skills, problem-solving tools in materials engineering with project-based study.

010633515 Seminar on Innovative Materials Engineering 1(0-2-1)

Pre-requisite : None

Seminar in the topics concerning conventional and latest materials research, effective presentation, good character in presentation, manners in the meeting, discussion on leading-edge and innovative technology in materials engineering, technological development and problems in materials engineering, proposing innovative materials engineering senior project.

010633516 Innovative Conceptual Engineering Design 3(2-2-5)

Pre-requisite : None

Fundamental techniques in conceptualizing, study of methods, processes, and conceptual thinking to develop products and concepts in the design of new and innovative products, emphasis will be placed on identifying user needs, concept generation, concept selection and prototype fabrication.

010633517 Materials Selection and Innovative Design 3(2-2-5)

Pre-requisite : None

Materials selection based on the required properties, design of component and products and economic consideration, selection of manufacturing process and materials forming, introduction to reverse engineering, case study for materials and process selection.

010633518 Innovative Materials Engineering Project I 1(0-2-1)

Pre-requisite : None

Research and technological development concerning innovative materials engineering, composing a senior project report explaining the conducted work, presentation.

010633519 Innovative Materials Engineering Project II 3(0-6-3)

Pre-requisite : 010633518 Innovative Materials Engineering Project I

Subject with the same content and continued from 010633518 Innovative Materials engineering project l.

010633520 Biocompatible Materials 3(3-0-6)

Pre-requisite : None

History of biomaterials. Classification of biomaterials; silicone, fibers, hydrogels, polymers, metals, ceramics, composites as biomaterials. Mechanical and chemical, bulk and surface properties of biomaterials; Roles of water on biomaterials. Background concepts of biology; Cell and cell injury; Cell-biomaterials interaction and chemical forces on cells. Compatibility to issues and organs; Inflammation and Wound healing; Innate and adaptive immunity; Toxicity and Hypersensitivity. Blood and materials interaction. Introduction to Testing biomaterials. Application of materials in medicine and artificial organs.

010633613 Quality Control and Management 3(3-0-6)

Pre-requisite : 040503011 Statistics for Engineers and Scientists

Definition and importance of quality, techniques and methods used by organization to achieve the quality required by customers, management and statistical operation of quality control practiced in production and service industries, quality system, quality management system, planning and implementation of the quality control system, quality assurance, application of the quality control and management for materials engineering.

010633614 Engineering Economy 3(3-0-6)

Pre-requisite : None

Principles and application of time-varying values of money and interest. Decision to select a proposal under different conditions. Selection of project by present worth analysis, annual worth analysis, and internal rate of return analysis. Calculation of depreciation, replacement analysis, break even point analysis, economic sensitivity analysis, applications of engineering economy for materials engineering.

040113001 Chemistry for Engineers 3(3-0-6)

Pre-requisite : None

Matters and scientific measurement, atoms molecules and ions, stoichiometry, electronic structure of the atoms, periodic properties, chemical bond, shape of molecules, gas liquid and solid, thermodynamics, chemical kinetics, chemical equilibrium, acid-base equilibrium, electrochemistry.

040113002 Chemistry Laboratory for Engineers 1(0-3-1)

Pre-requisite : 040113001 Chemistry for Engineers

All experiments are corresponded to the course of 040113061 Chemistry for Engineers.

040203100 General Mathematics 3(3-0-6)

Pre-requisite : None

Mathematical structure, inductive and deductive reasoning, arguments and their validity, rectangular and polar coordinate systems, elementary functions, rates of change and derivatives, sequences and series, introduction to graph theory, mathematics of finance, applications of selected topics.

040293111 Engineering Mathematics and Computation I 3(3-0-6)

Pre-requisite : None

Mathematical induction; sequences and series of numbers; limit, continuity. Differentiation of real-valued functions of a real variable, Taylor series expansions of elementary functions, their applications; indeterminate forms. Integration of real-valued functions of a real variable and their applications; techniques of integration; improper integrals. Applications of derivative. Mathematical problem solving using appropriate software packages.

040293112 Engineering Mathematics and computation II 3(3-0-6)

Pre-requisite : 040293111Engineering Mathematics and Computation I

Calculus of real-valued functions of two variables, calculus of real-valued functions of several variables and their applications. Lines, planes, and surfaces in three-dimensional space; Polar coordinates. Vector algebra in three dimensions; differentiation and integration of vector-valued functions and their applications. Introduction to line integrals. Mathematical problem solving using appropriate software packages.

040313005 Physics I 3(3-0-6)

Pre-requisite : None

Vector, Mechanics of motions, Newton's law of motion, Motion along a straight line, Circular motion, Simple harmonics motion, Superposition of two simple harmonics, Damped oscillation, Forced oscillation, Types of waves, Standing waves, Shock waves, Beats, Intensity and sound level, Doppler effect, Moment of inertia, Equations of rotational motion, Torque, Angular momentum, Rolling, Precession of a gyroscope, Properties of materials, Heat transfer, Ideal gas equation, Laws of Thermodynamics, Heat engines and reverse engine, Physical properties of Fluid, Buoyancy, Pascal's law, Equation of continuity, Bernoulli's equation, Pressure measurement, Flow measurement.

040313006 Physics Laboratory I 1(0-2-1)

Pre-requisite : 040313005 Physics I

This laboratory is related to the class 040313005 Physics I.

040313007 Physics II 3(3-0-6)

Pre-requisite : 040313005 Physics I

Properties of waves, Reflection, Interference, Diffraction, Geometrical optics, Optical instruments, Coulomb's law, Electric fields, Gauss's law, Electric potential. Dielectric, Capacitor, Magnetic fields, Lorentz's force, Biot-savart's law, Ampere's law, Electromotive force, Inductor,

Magnetic materials, Alternating, X-rays, Hydrogen atom, Duality, Many electrons atoms, band theory, Structure of nucleus, Radioactivity, Nuclear reactions.

040313008 Physics Laboratory II 1(0-2-1)

Pre-requisite : 040313007 Physics II

This laboratory is related to the class 040313007 Physics II.

040313016 Physics in Daily Life 3(3-0-6)

Pre-requisite : None

Discovery with impact on human society, importance of physics toward the international community evolution, understanding the relation between physics and natural phenomena, application of physics in daily life.

040313017 Exercise Skill and Sport 3(3-0-6)

Pre-requisite : None

Types of exercise, physical training methods, the change of body systems during exercise, injury and protection in sports, the improvement of body's performance, nutrition and performance of exercise.

040313018 Human Body and Health 3(3-0-6)

Pre-requisite : None

Basic components and functions of body parts, movement system, cardiology system, excretion system, reproduction system, basic health care.

040503001 Statistics in Everyday Life 3(3-0-6)

Pre-requisite : None

Overview statistics in everyday life. Problem solving systems using statistically logical skill. The uses of statistics in social science, humanity, government, sport, education, advertisement, finance, epidemiology, or others.

040503011 Statistics for Engineers and Scientists 3(3-0-6)

Pre-requisite : None

Fundamentals of statistic, sample space and probability; sampling variables and probability function; expectation values, deviations and variants; discontinuous and continuous sampling variables, statistic induction: estimation and statistic experimentation of hypothesis; variant analysis; fundamental regression and correlation analysis. Engineering and scientific problem-solving using appropriate statistical software packages.

080103001 English I 3(3-0-6)

Pre-requisite : None

Integrated skills of listening, speaking, reading, and writing at basic level in order to apply in daily life with the cultural awareness of diverse users. Learning vocabulary and grammatical structures through conversations, academic and general journals. Writing non-complex sentences and paragraphs. Extensive practice at Self-Access Learning Center (SALC) and through e-Learning.

080103002 English II 3(3-0-6)

Pre-requisite : 080103001 English I

Integrated skills of listening, speaking, reading, and writing at basic level in order to apply in daily life with the cultural awareness of diverse users. Learning vocabulary and grammatical structures through conversations, academic and general journals. Writing complex sentences and paragraphs. Extensive practice at Self-Access Learning Center (SALC) and through e-Learning to promote life-long learning.

080103012 Reading I 3(3-0-6)

Pre-requisite : 080103002 English II or 080103062 Practical English II

Reading techniques and strategies. Encouraging students to develop their reading abilities through class activities and self-access learning.

080103016 English Conversation I 3(3-0-6)

Pre-requisite : 080103002 English II

Fundamental skill in pronunciation and speaking skill for communication in daily life. Self introduction, describing things, and expressing opinions.

080103017 English Conversation II 3(3-0-6)

Pre-requisite : 080103016 English Conversation I

Pronunciation and speaking skill with complex sentences in both prepared and impromptu situations. English communication skills in daily life with an emphasis on speaking and listening.

080103018 English for Work 3(3-0-6)

Pre-requisite : 080103002 English II or 080103062 Practical English II

Language skills for work, writing job applications, simple business letters, memos and minutes. Job interviews, making appointments, welcoming visitors, negotiations, describing job positions and products. Writing, presenting, and assessing projects.

080203901 Man and Society 3(3-0-6)

Pre-requisite : None

The relationship between human beings and society, human society and settlement, social organization, culture, social institutions, social changes, social problems, and social development.

080203905 Economy and Everyday Life 3(3-0-6)

Pre-requisite : None

Fundamental economics in everyday life, e.g., consumption, investment, inflation, deflation, financial institutions, taxation, various economic conditions, economic problems, government direction in economic problem solving, self-adaptation to various economic situations.

080203907 Business and Everyday Life 3(3-0-6)

Pre-requisite : None

The essential of business in everyday life, business environment, types of business, business management, business information technology management, business ethics and social responsibility.

080303601 Human Relations 3(3-0-6)

Pre-requisite : None

Principles and theories of human behavior, understanding one's self and others', self - development, communication, team working, leadership, conflicts and conflict management, society and culture, social etiquette, religious principles and application to enhance human relations.

080303606 Systematic and Creative Thinking 3(3-0-6)

Pre-requisite : None

Concepts of system, neurological system, psychological process to understand human's thought: systematic thinking, analytical thinking, strategic thinking, synthesis thinking, creative thinking, integrative thinking, techniques for developing thinking.

3.1.6 Lecturers

Refer to item 9 of section 1.

4. Configuration of the industrial internship

The internship is performed with governmental or private, international or domestic organizations with the period not less than 240 hours. Along with the internship, students are urged to apply knowledge in the field of materials engineering at their training places, such as failure analysis of material, quality control, material testing and chemical degradation.

4.1 Standard of learning outcomes from internship

(1) Knowledge, techniques and skills in using tools or machines
(2) Analysis skills for solving problems in an actual situation
(3) Good interpersonal skills
(4) Ability to follow the discipline of an organization
(5) Communication skills

4.2 Time frame

The total time must be not less than 240 hours.

4.3 Class schedule

Each regular student should fill up one summer study period of the third year for his/her internship. While a student who attends the 2+2 program or another exchange program with another institute or university can report his/her internship during the exchange period. A project based course which provides not less than 240 hours of enrollment can be transferred as an internship course.

5. Regulations for a senior project of innovative material engineering

In this curriculum, every student must accomplish a senior project in English language consisting of:

5.1 Short description

A project or a senior project is related to the innovation on technology of materials engineering. A student in charge is able to explain theories and benefits related to his/her project. The scope of a project must be well planned and must be able to be completed within the time limit.

5.2 Standard of learning outcomes from the project

Operation on a senior project must yield the following benefits to a student

(1) Knowledge
(2) Problem solving skills by mean of research
(3) Information searching skills
(4) Data analysis and computer skills
(5) Good interpersonal skills
(6) Presentation and writing skills of English language

5.3 Time frame

Two semesters of the fourth year

5.4 Number of credits

IME project 1 for ‘1 credit’ and IME project 2 for ‘3 credits’.

5.5 Preparations

Project advisors and students discuss together for preparations as follows:

(1) Project advisors suggest topics for projects. Students can propose a project in which he/she is interested.
(2) Project advisors schedule discussions with students regarding the progress of the preparations
(3) Project advisors and students prepare equipments, such as computers, tools, machines, chemicals, and so on.

5.6 Process of evaluation

The department will assign a committee comprised of lecturers to examine and evaluate projects. The process of verification is as follows:

(1) Project evaluation by lecturers of the department and advisors for each semester.
(2) A student presents his/her project and submits a midterm report. Not less than three advisors follow up and verify the progression of a project.
(3) The overview assessment of a project will be followed up by outcomes of each process during the whole year and be reported by project advisors.

5.7 Requirements of the application for the project examination

Projects must be accomplished or expected to be complete within the timeframe. Before applying for the project examination, students must provide the following;

(1) Abstract
(2) Documents for presentation
(3) Senior project

Section 4 Learning outcomes, teaching strategies and evaluation

1. Student's personal development

Characteristics	Strategies or activities of students
1. Awareness and good perspective towards professional ethics	Incorporated into the teaching of every subjects
2. Skill of leadership and team working	Assigning group projects
3. Discipline and responsibility	Incorporated into the coursework, work assignments, and mini projects
4. Creativity and ability to create innovation	Learning by project, in the same time making students cultivate the innovative skills

2. Learning outcome development

2.1 Morals and ethics

2.1.1 Learning outcomes in morals and ethics

1. Understanding and appreciation of Thai culture. Recognition of values in morals, ethics, sacrifice and honesty.

2. Be disciplined and punctual. Self and social responsibility. Respecting rules and regulations of organization and society.

3. Having leadership and being good listeners. Capabilities to do teamwork. Conflict resolution by prioritization. Respect of the rights and opinions of others, as well as human rights and dignity.

4. Capabilities of analysis and evaluation of impact using engineering knowledge on persons, organization, society and environment.

5. Possession of academic and professional ethics, professional responsibility. Understanding the social aspect of certain fields of engineering from the past to present.

2.1.2 Morals and ethics development strategies.

1. Learning from actual situations.
2. Incorporation into coursework.
3. Leadership models presented by lecturers.
4. Setting activities.
5. Teaching by case studies.

2.1.3 Evaluation strategies of leaning outcomes for development of morals and ethics

1. Student's self-evaluation before and after learning.
2. Evaluation by lecturers using observation.
3. Morals and ethics evaluation of the graduates by recruiter.

2.2 Knowledge

2.2.1 Learning outcomes in knowledge

1. Possession of the knowledge and understanding in fundamental mathematics, fundamental sciences, fundamental engineering and economics, for the application to related engineering works and technological innovation.

2. Possession of the knowledge and understanding on important principles in both theoretical and practical contents of specific field of engineering.

3. Capable of integration of academic knowledge in student specific field to other related fields.

4. Capable of analysis and problem solving by using appropriate methods including the utilization of the appropriate tools, i.e. computer software etc.

5. Capable of utilizing specific field of knowledge and skills in practical problem solving.

2.2.2 Teaching strategies in knowledge learning development

Use various formats of learning, especially distinguishing theoretical principles and practical application in actual environments, catching up with the changing technology and in accordance with the nature and content of each subject. Furthermore, students should have opportunities to learn from actual situations by site visits/excursions, attending talks by invited specialists who have direct experiences in the specific topics, as well as having internship in a company.

2.2.3 Evaluation strategies of leaning outcomes in knowledge development.

Evaluation of learning and practices achievement by students using the following methods;

1. Test
2. Mid-term and final examination
3. Evaluation by assigned student report.
4. Evaluation by presented plan or project.
5. Evaluation by presentation in class.

2.3 Cognitive skills

2.3.1 Learning outcomes in cognitive skills

1. Thinking with proper judgment.

2. Capable of collection, study, analysis, and summarization of problems and requirement.

3. Capable of systematic thinking, analysis and solving the engineering problems, as well as using the information to make an effective decision.

4. Having an imagination and flexibility in appropriately applying a set of related knowledge on constructive innovation developments or deployment of existing knowledge.

5. Capable of information searching and pursuit of additional knowledge by his/herself, leading to lifetime learning and catching up with the change in new knowledge and technology.

2.3.2 Teaching strategies in cognitive skill development

Teaching based on student-centered learning, associated with student training on searching for information or implementation of mini-project, group discussion and practical work.

2.3.3 Evaluation strategies of leaning outcomes for cognitive skill development

Evaluation by actual results of assignments and student’s practices, for examples, presentation in class and test.

2.4 Interpersonal skills and responsibility

2.4.1 Learning outcomes in interpersonal skills and responsibility

1. Capable of communications with diverse groups of people, effective conversation in English languages and using the professional knowledge to communicate towards society in the appropriate topics.

2. Capable of initiating a constructive expression of the issue for problem solving on both individual and common situations and moderately appealing the stances of his/her individual or group, as well as helping or facilitating on situation breakthrough.

3. Capable of planning and responsibility on development of his/her own learning, and with professional conformation.

4. Knowing the role and duty as well as being responsible for both individual and group assigned works, capable of effective adaptation and team working both as a leader and a follower and also taking an appropriate attitude with regards to his/her responsibility.

5. Possession of recognition on work safety and environment preservation.

2.4.2 Teaching Strategy for development of learning skills in interpersonal relationships and responsibility.

The instructor assigns group activities. The activities need to coordinate with students of other curricula and/or interview the people or experienced persons for more information from various fields. The expected results from the learning skills of the individuals and the ability of responsibilities are as follows.

1. Ability to work with other persons.
2. Responsibility for the assigned work.
3. Ability adaptation to the situations and culture within the workplace.
4. A good relationship with colleagues and public.
5. Leadership

2.4.3 Evaluation Strategy of leaning outcomes for the interpersonal skills and responsibility.

Evaluation could be based on the expression of students through their presentations, group work in class, and the behavior of students in various activities which should be clear in the evaluation checkpoints.

2.5 Numerical analysis skill, communication and information technology.

2.5.1 Effective learning skills in communication, numerical analysis and information technology

1. Good skills to use the computer for related work.
2. Good skills to analyze mathematical information data or to apply statistics and to solve the problems.
3. Ability to use the modern information technology and communications appropriately and effectively.
4. The communication skills in writing, speaking and the interpretation of symbols.
5. Ability to use various calculation tools and engineering tools in the fields of engineering involved.

2.5.2 Teaching strategy for development of communication skills, numerical analysis and information technology.

A lecturer organizes activities or virtual situations in class for students to simulate analysis skills. Demonstration of some appropriate solutions will be made to students and students will be encouraged to learn techniques for using information technology in a variety of situations.

2.5.3 Evaluation Strategy of leaning outcomes for the numerical analysis skill, communication and information technology.

The lecturer evaluates the presentations and techniques of students based on theoretical methods and the choices made in relation to information technology or mathematics and statistics.

2.6 **Innovative skills**

The highlight of this curriculum is conveying to students the additional skills on innovation. The skills could be created by consistently or continually practicing these actions—questioning, observing, experimenting, networking, and associating—triggering associational thinking to deliver innovations, new businesses, products, services, and/or processes.

2.6.1 Learning outcomes

1. Questioning – Asking questions that challenge common wisdom
2. Observing – Scrutinizing theories, lectures, articles or inventions to identify new ways of doing things
3. Experimenting – Constructing interactive experiments that provoke unorthodox responses to see what insights emerge.
4. Networking – Meeting people with different ideas, backgrounds, and perspectives.
5. Associating – Connecting the unconnected across questions, problems, or ideas from unrelated fields.

2.6.2 Teaching strategy for development of the innovative skills

Courses in the group d. innovative materials engineering which motivate the construction of innovative skills are implemented in this curriculum. Through the courses, lecturers show the importance of questioning, observing, experimenting, networking and associating, and assign group works or mini projects in class. Lecturers or project advisors together with students have to set the scope of the assignments in order to obtain the solid outcomes. The students could familiarize these actions through practice.

2.6.3 Evaluation strategy of leaning outcomes for the innovative skills.

Solid outcomes are expected and to be graded for the subjects. Students can present their works in order to be evaluated by lecturers or project advisors.

3. A standardized map of the distribution of the responsibilities from the learning outcomes curriculum to course.

The lecturers in the curriculum evaluate their own courses according to the learning outcomes. After the evaluation the table of distribution of learning outcomes will be made, see Appendix C. The table shows the fulfillment of the expected learning outcomes. If courses in the curriculum can not gather the outcomes adequately, a course can be improved or revised by the lecturer. The meanings of the learning outcomes in each category are as follows;

3.1 Morals and ethics

1. Understanding of Thai culture. Awareness of the value of sacrifice and moral integrity.
2. Discipline, punctuality, self and social responsibility. Respect of the rules and regulations.
3. Leadership and being good listeners. Working as a group. Ability to resolve conflict by prioritization. Respecting the rights and opinions of others, including worth and dignity of human beings.
4. Ability to analyze and assess the impact of usage of engineering knowledge to personal, organizational and social environments.
5. Ethics in academic and professional contexts. Responsibility as a trader. Understanding the social context in each engineering field from past to present.

3.2 Knowledge

1. Knowledge and understanding the fundamentals of mathematics, sciences, engineering and economics. Applying the knowledge in the related areas of engineering. Using the knowledge to build up innovative technology.
2. Knowledge and understanding of the principles in both of theoretical and practical contexts and also in a specific area of engineering.
3. Integrating knowledge in the field of study with other related disciplines.
4. Ability to analyze and solve problems using the right approach, including appropriate tools such as computer programs, etc..
5. Ability to apply knowledge and skills in their fields to solve problems in any working situations.

3.3 Cognitive skills

1. Good critical thinking.
2. Ability to think, analyze and solve problems in an engineering system, including the use of the information to make their decision effectively.
3. Ability to study, gather, analyze and summarize all of the issues.
4. Using the imagination and flexibility to organize the relevant knowledge appropriately in the innovative development or extension the existing knowledge.
5. Ability to search information and seek knowledge on their own for lifelong learning and keep up to date in the knowledge and new technologies.

3.4 Interpersonal skills and responsibilities.

1. Ability to communicate with diverse groups of people and make effective conversation in both Thai and foreign languages. Ability to use the knowledge in their field to communicate to society on appropriate issues.
2. Ability to show creativity in solving innovative issues in both personal and group situation. Expressing the appropriate standpoint of the individual and the group. Ability to give assistance or support in solving troubles in any situations.
3. Planning and taking responsibility for their own learning and related work.

4. Knowing the roles and responsibilities in the assigned work, in both individual and group working. Ability to adapt to work with others, both as leaders and followers.
5. High responsibility for safety in the workplace and the work environment.

3.5 Numerical analysis skills, communication and information technology.

1. Good skills in using the computer for related work.
2. Good skills in analyzing mathematical information data or in applying statistics to solve the problems.
3. Ability to use modern information technology and communications appropriately and effectively.
4. Communication skills in writing, speaking and interpretation using symbols.
5. Ability to use various calculation tools and engineering tools in the fields of engineering involved.

3.6 Innovative skills

1. Pursuing one's interest into questioning both on general and critical viewpoints.
2. Ability to observe and conceive circumstances scientifically.
3. Ability to perform and design experiments which are appropriate to the problems
4. Being aware of the need to collaborate and network with people from various fields.
5. Ability to associate ideas of various field

Section 5 Criteria for Student Evaluation

1. Criteria for grading system

Accordance to the regulations set by the King Mongkut's University of Technology North Bangkok in 2009 and modified in 2011.

2. The process of verifying standards of student achievements

All contents of verification of standards are able to be assessed by accreditation agencies or auditors from outside.

2.1 Verification process for standards of learning outcomes for ongoing students.

2.1.1 Arranging the verification of learning outcomes on accordance with the quality assurance system of KMUTNB.

2.1.2 Arranging the verification of courses in the curriculum, such as verifying the paper tests used in the midterm or final examinations by curriculum committee.

2.1.3 Arranging the verification of the curriculum on accordance with the quality assurance system of KMUTNB.

2.2 Verification process for standards of learning outcomes for graduates.

2.2.1 The achievement in job hunting will be assessed in terms of the time span spent before the graduate gets a job, opinions on their knowledge, ability, and confidence in their professions.

2.2.2 Employer assessment of their satisfaction with graduate work.

2.2.3 External committee participation in the evaluation and revision of the curriculum.

3. Requirements for graduation

Accordance to the item No. 2.3 in the section 3

Section 6 Faculty Development

1. Preparation for new instructors

(1) There is an orientation for new instructors to familiarize themselves with the department, faculty and university for a better understanding about objectives and goals of the curriculum following the Thai Qualification Framework for Higher Education. Mentors are assigned to advise as a consultant in the field of education.

(2) Guidance to the philosophy, objectives and goals of the program and courses.

(3) All new instructors are required to understand the academic management and quality assurance of the department.

(4) All new instructors are required to attend training courses to develop skills on teaching, using media and information technology, teaching evaluation, student analysis, research in teaching development, constructing a course syllabus and course outline.

(5) There is introduction for guest instructors to understand the objectives and curriculum and the related documents will be provided to the guest instructors.

(6) There is evaluation on teaching performance of instructors.

2. Development of skills and knowledge for instructors

2.1 The development of skills in academic management, measurement and evaluation

2.2.1 The university provides two training courses for new instructors to improve knowledge and skills in teaching, measurement and evaluation. The new instructors must be trained within 1 year.

2.1.2 At least 25 percent of all instructors must complete 10 hours of the training courses consisting of teaching, test construction, evaluation on learning development and using media and information technology.

2.1.3 Attending a seminar on teaching skills development, measurement and evaluation.

2.1.4 Arranging for new instructors opportunities to exchange knowledge and experience in teaching management for knowledge sharing and teaching development at least once a semester.

2.1.5 Instructors will be encouraged to request appraisals of their instruction by fellow instructors.

2.2 Other academic and professional skills

2.2.1 New instructors are encouraged and supported to attend training courses and conferences in the academic or professional organizations, both within and outside the university.

2.2.2 Instructors are encouraged to produce academic works in order to achieve a higher academic position.

2.2.3 Instructors are encouraged to produce research both academic and educational researches.

2.2.4 Instructors are encouraged to participate in academic and professional tours to various organizations, and attend academic meetings and conferences in order to become experts in their field.

2.2.5 Arranging websites, brochures and knowledge development.

2.2.6 Instructors are encouraged and supported to present research work in journals or academic publications and study at other institutes and organizations.

Section 7 Quality Assurance of the Curriculum

1. Curriculum Management

1.1 The department has set up the curriculum committee, consisting of three lecturers and the head of department who will give advice and policies to all instructors.

1.2 All faculty members plan the management of the curriculum with the administrative committee of the department and the lecturers follow up the plan and collect data.

1.3 Organizational meetings will be scheduled before the beginning of the academic year.

1.4 Instructors will be assigned to produce course descriptions, course reports, development and evaluation data for annual revision of the curriculum.

1.5 There is the annual revision of courses on student learning outcomes (at least 60 percent from all of the courses).

2. Management of teaching materials and resources

2.1 Budget management

The faculty is allocated sufficient annual budget for textbooks, teaching materials for instructors, student development, academic services, research apparatus, computers, etc. in order to provide a suitable research environment.

2.2 Existing teaching and learning resources

The central library of KMUTNB provides and manages services for textbooks, journals and an on-line database. In addition, the faculty of engineering library provides the books and journals in the related fields of Materials Engineering.

2.3 Supplying Education and Teaching resources

The central library of KMUTNB will supply textbooks and educational documents to lecturers and students. The lecturers can participate with the central library to suggest the list of textbooks, educational documents and other medias. Furthermore, special guest instructors of some courses and some topics will also be able to suggest the list of textbooks. The lecturers and special guest instructors can apply to use some units in the laboratory of Thai-French Innovation Institute.

2.4 Educational and Teaching Resource Sufficiency Evaluation

2.4.1 The lecturers and participants can advise the essential educational and teaching resources at anytime.

2.4.2 The lecturers and participants are responsible for preserving and facilitating the audiovisual aids to the students and lecturers. Besides, there is also the resource sufficiency evaluation for lecturers.

3. Human Resource Managements

3.1 Lecturer Recruitment

The recruitment of new lecturers is done continuously, according to the regulations of the university.

3.2 The cooperation of lecturers to plan, follow up and revise the curriculum.

The core lecturers and the lecturers who are in charge of subjects taught in the curriculum will arrange meetings to revise or give official approval mutually. Moreover, they will compile the data for

preparing for improvement. They will give further advice to achieve the objectives of the curriculum and make prospective graduates.

3.3 Special lecturer appointment

The special lecturer appointment is very important because the special lecturer will pass on direct or industrial experiences to students. Therefore, the special lecturers of a subject or a topic must have direct or industrial experiences and a master's degree.

4. Education Support Staff Performance Management

4.1 The specific requirement of the position

The education support staffs should have a bachelor's degree relating to the position and have knowledge in materials or production technology.

4.2 Knowledge creation and acquisition for working

The staff have to understand structures and characteristics of the program and can also provide service to the lecturers for using instructional media. Hence, the staff need to have special training e.g. maintenance and research equipment preparation training programs.

5. Student Advice and Support Services

5.1 General academic and other advice

The department of Materials and Production Technology Engineering provides advisors to advise students in registrations and with regards to problems of studying. The advisors must have office hours for the students. Moreover, the department has to provide activities for students, and students can consult the advisors on the arrangement of the activities.

5.2 Student Appeals

The students can file a request to see answer sheets, scores and the evaluation of each subject.

6. Requirements of labor market, society and/or the satisfaction of entrepreneurs

Materials Engineers and Researchers who have ability to work and match the requirements for the industrial sector.

7. Key Performance Indicators

Key Performance Indicators (KPI)	1st year	2nd year	3rd year	4th year	5th year
1. At least 80% all full-time instructors in each program have to participated in meetings that set up plans to evaluate and revise the curriculum	√	√	√	√	√
2. The program must have the details of the curriculum according to TQF2 which is associated with the Thai Qualifications Framework or the standards of the program (if any)	√	√	√	√	√
3.The program must have course specifications and field experience specifications (if any) according to TQF3 and TQF4 before the beginning of each semester	√	√	√	√	√
4. Instructors must produce course reports and file experience reports (if any) according to TQF5 and TQF6 within 30 days of the end of the semester.	√	√	√	√	√

5. Instructors must produce program reports according to TQF7 within 60 days of the end of the academic year	√	√	√	√	√
6. Instructors must revise the grading of students according to learning standards indicated in TQF3 and TQF4 (if any) for at least 25 percent of courses that are offered each academic year.	√	√	√	√	√
7. Instructors must assess the development and/or improvement of teaching methods, teaching techniques or the grading system from the evaluation results in TQF 7 of the previous year.	√	√	√	√	√
8. Every new instructor (if any) has to participate in the orientation and receive adequate information on the college's teaching requirements.	√	√	√	√	√
9. Full-time instructors must demonstrate academic and/or profession improvement at least once a year.	√	√	√	√	√
10. The number of supporting staff (if any) who demonstrate academic and/or professional improvement by at least 50 percent each year.	√	√	√	√	√
11. The level of satisfaction from the previous year's students and new graduates toward curriculum quality, with an average score of at least 3.5 out of 5.				√	√
12. The level of satisfaction from employers of new graduates with an average score of at least 3.5 out of 5.					√
Total key performance indicators (items) for each year	10	10	10	11	12
Required performance indicators (items)	1-5	1-5	1-5	1-5	1-5
Performance indicators that need to pass expectations	9	10	10	10	12

Evaluation criteria: A curriculum that meets the standards of Thai Qualifications Framework must qualify for the following conditions: (1) the compulsory performance indicators(number 1 - 5) must pass beyond expectations and (2) the total number of performance indicators must reach their goal by no less than 80 % each year.

Section 8 Evaluation and Improvement of curriculum

1. Evaluation on Teaching Effectiveness.

1.1 Evaluation of teaching strategies

Teaching should be oriented to students. Lecturers should explain the contents of the courses and suggest textbooks for reading to make students cultivate self-study skill. In class, the lecturer should show the derivation of theories and rules or important concepts, because doing this brings about obvious and scientific reasons to students. Talking about analytical examples also helps to identify the relation between theories and applications. In addition, this curriculum promotes lecturers to implement experiments and surveys in their courses for practicing the innovative skills such as experimenting and networking. There are other strategies which lecturers should apply or develop to achieve all of the learning outcomes, such as group assignments, debating, presentations, problem solving, and guiding about attitudes on morals and ethics in case of confronting any conflicts among students in class.

1.1.1 Evaluation by tests, subtests, observation of student behaviors, interactive discussion of students, the answering of questions of students in class. If the method cannot be used to make the learners understand, then the teaching methods should be reconsidered. Understanding of learning context of a student will be able to be identified by mid-semester and end-of-semester tests. If there are problems, instructors will have to conduct research to improve teaching and learning in the future.

1.1.2 Analysis of student evaluation towards teaching strategies. Students can evaluate teaching strategies in terms of whether they are comprehensive, effective, within time span, and meet learning outcomes or not. Criteria of the evaluation include explanation, expression and usage of media involving in instruction of all courses.

1.1.3 Teaching observation by representatives of the department.

1.2 Evaluation of lecturers' skills in using teaching strategies

1.2.1 Analysis from student evaluation toward courses and lecturers. Students can evaluate teaching in all aspects such as strategies or skills of teaching and punctuality to clarify course goals and objectives. Criteria of the evaluation include explanation, expression and usage of media involving in instruction of all courses.

1.2.2 Workshop on courses in the curriculum improvement with the participation of all lecturers in the courses

2. The overall evaluation.

The overall evaluation is done continuously every year by focusing on students' learning outcomes, then comparing them to the curriculum mappings. It is necessary here to identify which parts of courses are inadequate in guiding students. All of the evaluation data will be collected to facilitate the improvements and development of the curriculum. Referring to the curriculum mappings of the academic year, the teaching process and strategies can be improved for both overall curriculum and each course separately.

3. Description of evaluation for the implementation of the program

Evaluation is made annually by the head of the department and lecturers according to key performance indicators of section 7, item 7. The committee is formed by at least 3 assessors, while including at least 1 expert in the field who has been appointed by the university. The evaluation criteria are shown in the table below.

Table of evaluation criteria

1 score	2 scores	3 scores
Having performed for 5 items as indicators of operating performance.	Having performed for 8 items as indicators of operating performance.	Having performed for 12 items as indicators of operating performance.

The university will periodically determine if the curriculum has been shown to improve the standard and quality of education index. This will be done at least every 3 years. Additionally, the courses will be evaluated for improvement every 3 years.

4. Revise the evaluation and improvement planning.

The curriculum administration committee and instructors will periodically revise their courses, collect data from evaluation results and perform mapping indicators from both the overall curriculum and each course. If there are any problems in a course, they are able to be solved or improved as a minor improvement. The minor improvement should be done right away by submitting the corrected curriculum to the Commission of Higher Education. Any major improvements will be made every 5 years in order to modernize the curriculum and requirement of the graduates. A curriculum in which major improvements has been made will be reconsidered by the university and the Commission of Higher Education. The curriculum administration committee will plan to improve and/or develop the curriculum by analyzing results from students' evaluations of instructors; job availability of graduates; level of employers' satisfaction with graduates; and other evaluation results that relate to courses, majors and the curriculum in order to improve or develop teaching and study methods.

Appendix A

3.1.5 Course descriptions

010113851 Basic Electrical Engineering 3(3-0-6)

Prerequisite: 040313007 Physics II

Basic DC and AC circuit analysis; voltage; current and power; transformers; introduction to electrical machinery; generators; motors and their uses; concepts of three-phase systems; method of power transmission; introduction to some basic electrical instruments.

010113852 Basic Electrical Laboratory 1(0-3-1)

Prerequisite: 010113851 Basic Electrical Engineering (or co-requisite)

Usage and experiment of electrical instruments and electrical experiments supporting basic electrical engineering subject.

010403099 Engineering Drawing 3(2-2-5)

Prerequisite: None

Specifications and standards of drawings; orthographic projection; orthographic drawing and pictorial drawings, dimensioning and tolerancing; sections, auxiliary views and development; freehand sketches, detail and assembly drawings; basic computer-aided drawing.

010403098 Engineering Materials 3(3-0-6)

Prerequisite: None

Study of retationship between structures, properties, production processes and applications of main groups of engineering materials i.e. metals, polymers, ceramics and composites, phase equilibrium diagrams and their interpretation, mechanical properties and materials degradation.

010623601 Engineering Mechanics 3(3-0-6)

Prerequisite: 040203151 Engineering Mathematics and computation I

040313005 Physics I

Force systems; resultant; equilibrium; fluid statics; kinematics and kinetics of particles and rigid bodies; Newton's second law of motion; work and energy, impulse and momentum.

010403096 Computer Programming 3(2-2-5)

Prerequisite: None

Computer concepts; computer components; hardware and software interaction; EDP concepts; program design and development methodology; high-level language programming. Computer based problem-solving.

010623602 Thermodynamics of Materials 3(3-0-6)

Prerequisite: None

Thermodynamic potential and equilibrium condition. Maxwell's relations. Heat capacity and thermodynamics of simple reactions. Equilibrium of one component and multi-phase

system. Construction of a binary phase diagram. Elementary tertiary phase diagram. Thermodynamics of reacting system consisting of multi-components and multi-phases. Reactions containing gaseous and condensed phases. Reactions containing multi-components in condensed solution. Electrochemistry. Statistical thermodynamic aspect to help explain the relevant macroscopic phenomena.

010623603 Mechanics of Materials 3(3-0-6)

Prerequisite: 010623601Engineering Mechanics (or co-requisite)

Forces and stresses; strain; stresses and strains relationship; stresses in beams, shear force and bending moment diagrams; deflection of beams, torsion; buckling of columns; Transformation of stresses and strains; Principal stress and strain; Mohr's circle and stresses under combined loading; failure criterion.

010623604 Transport Phenomena in Materials Processing 3(3-0-6)

Prerequisite: None

Laminar flow and turbulent flow. Newton's viscosity law. Mass-balance equation. Momentum-balance equation. Similitude and dimensional analysis. Flow in pipe. Conduction, convection and radiation. Energy-balance equation. Fick's law of diffusion. Analytical and numerical methods for applications in materials processing. Equipments associated with transport phenomena in materials processing.

010623605 Fundamentals of Materials I 3(3-0-6)

Prerequisite: None

Crystal structure; Crystal defects; Crystal interfaces and microstructure; Crystal structures of metals and ceramics; Solid solution and compound; phase equilibrium diagrams of metals, alloys and ceramics; Solidification; diffusion; principle of solid-state phase transformation; Plastic deformation in crystalline solid; recovery, recrystallization and grain growth; Strengthening mechanism and microstructural control. Mechanical properties of metals and ceramics.

010623606 Fundamentals of Materials II 3(3-0-6)

Prerequisite: None

Type of polymers and classification. Polymerization techniques. Structure of polymers. Conventional and engineering polymers. Copolymer and polymer blends. Classification of polymer composites. Manufacturing of polymers and polymer composites. Properties and applications of polymers and polymer composites. Rubber Technology.

010623607 Mechanical Behavior of Materials 3(3-0-6)

Prerequisite: None

Stress-strain relationship of metals, ceramics and polymer. Mechanical behavior of composite materials. Effect of structual arrangement of materials on their mechanical properties. Elasctic and plastic behaviors of materials. Dislocation theory. Mechanical testing, i.e. tensile, hardness, torsion, impact, fatigue and creep testing. Fracture mechanics. Failure of materials.

010623608 Electronic properties of Materials 3(3-0-6)

Prerequisite: None

Introduction of electronic materials—semiconductors, optic, magnetic and dielectric materials. The transport phenomena of electrons and holes in semiconductors, along with semiconductor devices such as PN junctions, transistors, photovoltaics, laser and so on. The light in solids and photonic devices. The magnetic phenomena in materials and magnetic devices such as disk drive, motor and transformer. The dielectric materials and devices, such as memory devices. Materials selection for among these devices.

010623609 Failure Analysis of Materials 3(3-0-6)

Prerequisite: 010623304 Mechanical behavior of materials

010623613 Environmental degradation and durability of materials

Failure analysis tools particularly in the practical aspect. Mechanical fracture. Failure due to corrosion. Failure due to wear, failure due to thermal processes. Case studies in failure analysis. Prevention of materials.

010623610 Materials Characterization 3(3-0-6)

Prerequisite: None

Basic chemical analyses. Spectroscopy techniques. X-ray characterizing techniques and electron spectroscopy (Scanning electron microscopy and Transmission electron microcope). Quantification of phase and grain size using optical microscope. Analyses of phase transformation using thermal and dilatometric methods. Thermal analysis such as TGA and DSC. Surface analysis using Atomic force microscopy.

010623611 Materials Forming 3(3-0-6)

Prerequisite: None

Theory and modern development of foundry processes. Gating and riser design. Pattern design. Finishing and inspection of castings. Casting design. Theory of mechanical forming processes of metals i.e. rolling, forging, extrusion, drawing and sheet metal forming. Source and elimination of defects. Forming processes of other materials such as polymers and ceramics.

010623612 Materials extraction and recycling 3(3-0-6)

Prerequisite: None

Thermodynamics of aqueous solutions. Kinetics of leaching and precipitation. Solvent extraction and ion exchange. Principle of hydrometallurgy. Electrochemistry of aqueous solutions. Current and energy efficiency. Principle of pyrometallurgy. Calcination, roasting and metal reduction. Extraction of ferrous and non-ferrous metals. Analytical methods in electrochemistry. Application in electrochemical engineering.

010623613 Environmental degradation and durability of materials 3(3-0-6)

Prerequisite: 040113061 Chemistry for engineers

Industrial and Innovative contexts in environmental degradation and durability of materials. Chemical and electrochemical thermodynamics of materials degradation. Gibbs free energy of chemical degradation. Ellingham diagram. Nernst equation. Pourbaix diagram. Determination of corrosion rate. Kinetics and transport phenomena in chemical degradation of materials. Electrochemical methods in the corrosion study, e.g., potentiodynamic and electrochemical impedance methods. Appearances, causes and remedies of corrosion in various forms, such as in the

forms of uniform, crevice, pitting, intergranular, selective, erosion, stress and high-temperature corrosion. Corrosion of engineering alloys. Chemical degradation of ceramics and polymers. Effects of environments on chemical degradation and durability of materials. Methods to prevent the chemical degradation of materials, including the electrochemical one. Case studies of corrosion and protection of materials in industries, as well as innovative materials to combat the corrosion.

010623614 Laboratory on Metallurgy 1(0-2-1)

Prerequisite: 010623605 Fundamentals of materials I (or co-requisite)

Laboratories in metallurgy with the content and practice corresponding to 010623605 Fundamentals of materials I.

010623615 Laboratory on Materials Testing 1(0-2-1)

Prerequisite: None

Laboratories in mechanical testing of materials with the fundamental mechanical testing, i.e. tensile, hardness, torsion, impact, fatigue and creep testing. Non-destructive testing. Innovative design of materials using mechanical testing with project-based study.

010623616 Laboratory on Materials Forming 1(0-2-1)

Prerequisite: 010623611 Materials Forming (or co-requisite)

Laboratories on materials forming with the content and practice corresponding to 010623611 Materials Forming. Innovative design of materials concerned with metal forming laboratory with project-based study.

010623617 Laboratory on Materials extraction and recycling 1(0-2-1)

Prerequisite: 010623612 Materials extraction and recycling (or co-requisite)

Laboratories in Materials Electrochemistry with the content and practice corresponding to 010623612 Extraction and recycling of materials. Galvanic corrosion. Electrolytic cells. Polarisation analysis. Anodic and cathodic corrosion protection. Innovative design of materials concerned with chemical metallurgy laboratory with project-based study.

010623651 Mathematical Methods for Materials Engineering 3(3-0-6)

Prerequisite: 040203152 Engineering Mathematics and computation II

Ordinary differential equations. Fourier series and integral transform. Solutions of partial differential equation using the technique of separation of variables. Solutions of partial differential equation using the transform method. Numerical differentiation and integration. Solving of differential equations by numerical methods. Vector and tensor analyses in mathematical modeling of transport phenomena. Application to the problems in transport phenomena, kinetics and mechanical behavior of materials.

Innovative materials engineering courses

010623618 Principles of Materials Engineering Innovation 3(2-2-5)

Prerequisite: None

Definition of innovation. Sources of innovative opportunities. Theory of disruptive technology, innovator’s dilemma and solution in metals and materials industries. Innovator’s DNA

and creative personalities. Discovery quotient. Case studies of iconoclasts as well as materials technological innovators.

010623619 Thinking-skills and Creativity Development for Materials Innovators 3(2-2-5)

Prerequisite: None

Description of Thinking. Thinking skills, for example, Comparative thinking, Analytical thinking, Critical thinking, Synthesis-type thinking, Conceptual thinking, Applicative thinking, Strategic thinking, Futuristic thinking, Integrative thinking, Logical thinking, Scientific thinking, Parallel thinking, Lateral thinking, Creative thinking, etc. Associational thinking for innovative skills. Problem-solving tools in materials engineering with project-based study.

010623620 Seminar on innovative materials engineering 1(0-2-1)

Prerequisite: None

Seminar in the topics concerning conventional and latest materials research. Effective presentation. Good character in presentation. Manners in the meeting. Discussion on leading-edge and innovative technology in materials engineering. Technological development and problems in materials engineering. Proposing innovative materials engineering senior project.

010623621 Innovative Conceptual Engineering Design 3(2-2-5)

Prerequisite: None

Fundamental techniques in conceptualizing. Study of methods, processes, and conceptual thinking to develop products and concepts in the design of new and innovative products. Emphasis will be placed on identifying user needs, concept generation, concept selection and prototype fabrication.

010623622 Materials Selection and innovative design 3(2-2-5)

Prerequisite: None

Materials selection based on the required properties. Design of component and products and economic consideration. Selection of manufacturing process and materials forming. Introduction to reverse engineering. Case study for materials and process selection.

010623623 Innovative Materials Engineering Project I 1(0-2-1)

Prerequisite: None

Research and technological development concerning innovative materials engineering. Composing a senior project report explaining the conducted work. Presentation.

010623624 Innovative Materials Engineering Project II 3(0-6-3)

Prerequisite: 010623623 Innovative Materials Engineering Project I

Subject with the same content and continued from 010623623 Innovative Materials engineering project l.

010623625 Phase Transformation 3(3-0-6)

Prerequisite: 010623605 Fundamentals of Materials l

First-order phase transformation. Gibbs phase rule. Thermodynamics of binary phase diagram. Tertiary phase diagram. Critical phenomena and second-order phase transformation. Non-equilibrium phase diagram. Solidification. Diffusion-controlled phase transformation. Diffusionless phase transformation.

010623626 Surface Engineering 3(3-0-6)

Prerequisite: None

Surface preparation and analyze before coating. Case hardening by various methods to enhance hardness and wear. Carburising. Nitriding. Chemical and physical vapor deposition. Thermal spray. Ion implantation. Wear phenomena.

010623627 Non-Destructive Testing 3(3-0-6)

Prerequisite: None

Various techniques in non-destructive testing, e.g. those using liquid dye penetrant, eddy current, magnetic powders, ultrasonic wave, and radioactive imaging. Comparison and application of the non-dstructive testing methods.

010623628 Tribology 3(3-0-6)

Prerequisite: None

Physical and chemical characteristics of materials surface. Friction between materials. Appearance and wear mechanisms for metals, polymers and ceramics. Surface damage. Boundary layer lubrication. Liquid and solid lubricants. Wear testing. Surface engineering to improve wear resistance. Case studies.

010623629 Safety in Materials Engineering 3(3-0-6)

Prerequisite: None

Causes and losses due to accident. Danger and its control from electrical machines. Boiler and pressure vessel. Materials handling. Safety due to the concern in heat, light, sound, vibration, radiation, chemicals, and bio- materials. Prevention and extinguishment of fire. Danger evaluation. Standard and laws concerning safety.

010623630 Energy and Environment in Materials Engineering 3(3-0-6)

Prerequisite: None

Situation and problems in energy and environment. Clean technology. Life cycle analysis of products. Energy management in materials industries. Pollutions from materials processing and remedies. Environmental regulations and standard for factories.

010623631 Metallurgy and Thermal Processing 3(3-0-6)

Prerequisite: None

Perfect crystal. Imperfect crystal. Equilibrium phase diagram of alloys. Non-equilibrium phase diagrams. Isothermal transformation diagram and continuous cooling diagram. Mechanisms of phase transformation. Strengthening mechanisms. Ferrous metals. Nonferrous metals. Annealing. Normalising. Hardening. Tempering. Stress-relief heat treatment.

010623632 Metallurgy and Thermal Processing Laboratory 1(0-2-1)

Prerequisite: 010623631 Metallurgy and Thermal Processing(or co-requisite)

Laboratories in metallurgy and thermal processing with the content and practice corresponding to 010623631 Metallurgy and thermal processing.

010623633 Foundry Engineering 3(3-0-6)

Prerequisite: None

Basic casting. Advanced casting. Pattern. Cavity. Core and its materials. Sand casting box and binders. Testing and control of properties of sand. Refractory. Casting furnace. Gating and riser systems. Solidification. Ferrous and non-ferrous casting. Casting design. Defects and remedies of casted materials. Safety in casting shop. Casting technology of cast metals, copper, copper alloyed with aluminium, aluminium alloyed with magnesium, magnesium alloyed with zinc, and zinc alloys. Low pressure casting process. High pressure casting process. Compression casting process. Semi-solid casting process.

010623634 Foundry Engineering Laboratory 1(0-2-1)

Prerequisite: 010623633 Foundry Engineering(or co-requisite)

Practice in elementary casting. Making a pattern made of wood. Making cavity using humidified sand. Making cavity using sand with dry surface and core. Feeding of aluminium, brass and cast iron melts to mould. Solidification behaviour of metals analysed using thermal analysis. Modification of grain size and microstructure of cast metals. Laboratory of low pressure casting. High pressure casting process. Compression casting process. Semi-solid casting process.

010623635 Welding Metallurgy 3(3-0-6)

Prerequisite: None

Methods of welding. Soldering. Brazing. Solid state and fusion welding. Effect of welding parameters on structure and properties of metals. Welding metallurgy of ferritic steels, austenitic steels, and nonferrous metals. Behaviour of welded metals used in service.

010623636 Heat Treatment of Metals 3(3-0-6)

Prerequisite: None

Annealing. Normalising. Hardening. Tempering. Controlling of atmospheres in furnace. Case hardening by carburizing and nitriding. Heat treatment of tool steels, special steels, cast iron, and non-ferrous metals.

010623637 Laboratory on Heat Treatment of Metals 1(0-2-1)

Prerequisite: 010623636 Heat Treatment of Metals (or co-requisite)

Practice in various methods of heat treatment, e.g. annealing, normalizing, hardening, tempering, case hardening. Microstructural analysis. Methods to measure case depth amd other mechanical properties of work pieces after heat treatment.

010623638 Powder Metallurgy 3(3-0-6)

Prerequisite: None

Metallurgy of powders. Production of powders by mechanical and chemical methods, as well as atomisation. Characterization of powders. Forming from powders and production of densed work pieces from powders. Methods to improve the properties of work piece. Microstructure and mechanical properties of work pieces made from powder metallurgical process. Application of metallic powders and work pieces made from powder metallurgical process.

010623639 Stainless Steels 3(3-0-6)

Prerequisite: None

Effects of alloying elements on structure and properties of stainless steels. Microstructure, physical properties, and mechanical properties of stainless steels. Passive film. Various groups of stainless steels, i.e. ferritic, martensitic, austenitic, duplex and precipitation-hardened stainless steels. Standards and criteria for the application of stainless steels in various works.

010623640 High-Temperature Materials 3(3-0-6)

Prerequisite: None

Nickel-based alloys, Niickel-Iron based alloys, Cobalt-based alloys, Other metal alloys used at high temperature service, Mechanical properties at high temperature, Reaction and Transformation of materials in environmental media at high temperature, Creep mechanism, Diffusion of Vacancies, Movement of line defects and grain boundary, Materials selection for high temperature application, Coating used for high temperature applications.

010623641 Aluminium Processing Technology 3(3-0-6)

Prerequisite: None

Classification of wrought and cast aluminiums. Effects of alloying elements. Changing in forming technology. Various types of aluminiums. Casting, forging, rolling, welding, and strengthening of aluminium.

010623642 High Temperature Corrosion and Protection of Materials 3(3-0-6)

Prerequisite: 010623001 Thermodynamics of materials

Industrial and innovative contexts of the high temperature corrosion. Characterizing tools in the study of high temperature corrosion. Thermodynamics of high temperature corrosion. Defect chemistry. Kinetics and transport phenomena in high temperature corrosion processes. Wagner's theory on oxidation. Mechanical properties of scale-metal interface. High temperature corrosion of metals and alloys. High temperature corrosion in various atmospheres, e.g., those containing carbon, nitrogen, sulphur, halogen and water vapour. High temperature corrosion by ash/salt deposit, molten salt and molten metals. High temperature corrosion protection. Case studies in high temperature corrosion and protection of materials in industries, as well as innovative materials to combat the high temperature corrosion.

010623643 Micro and nano electromechanical systems 3(3-0-6)

Prerequisite: None

Micro/nano materials and devices. Micro/nano scale fabrication and manufacturing processes. Micro/nano sensors and actuators. Device mechanism and assembly technology. MEMS and NEMS applications and innovations.

010623644 Introduction to nanotechnology for materials engineering 3(3-0-6)

Prerequisite: None

The fundamental of nanotechnology for materials engineering. Overview of physical and chemistry for nanomaterials. Synthesis and fabrication of nanomaterials. Characterization techniques of nanomaterials. The applications of nanomaterials in commercial products.

010623645 Polymer Colloids 3(3-0-6)

Prerequisite: None

Fundamental of colloid chemistry and self-assemble of particles in nanotechnology. Structure and properties of polymer colloid. Synthesis and formation of polymer colloids. Hybrid colloid materials. Characterization techniques of colloids and their hybrid, such as Light scattering. Polymer colloidal applications.

010623646 Polymer Processing and Rheology 3(3-0-6)

Prerequisite: 010623606 Fundamentals of Materials II

Introduction to rheology and classification of fluids. Viscoelastic behavior of polymeric system. Conventional injection molding processes and troubleshooting. Innovative injection molding processes. Extrusion and related processes. Compression molding. Melt spinning. Calendering. Vacuum forming. Rotational molding. Computer-aided-engineering (CAE) technology in polymer processing.

010623647 Fracture mechanics of materials 3(3-0-6)

Pre-requisite : none

Introduction to the mechanics of fracture of linear and nonlinear materials. Crack stress and deformation fields; stress intensity factors; crack tip plastic zone; fracture toughness testing; energy release rate; J-integral. Fatigue failure, subcritical crack growth, stress/life and damage-tolerant design approaches. Creep deformation.

010623648 Biocompatible Materials 3(3-0-6)

Prerequisite: None

A history of biomaterials. Classification of biomaterials; silicone, fibers, hydrogels, polymers, metals, ceramics, composites as biomaterials. Mechanical and chemical, bulk and surface properties of biomaterials; Roles of water on biomaterials. Background concepts of biology; Cell and cell injury; Cell-biomaterials interaction and chemical forces on cells. Compatibility to issues and organs; Inflammation and Wound healing; Innate and adaptive immunity; Toxicity and Hypersensitivity. Blood and materials interaction. Introduction to Testing biomaterials. Application of materials in medicine and artificial organs.

010623649 Special Topics in Materials Engineering I 3(3-0-6)

Prerequisite: None

Study in the interesting topics in materials engineering.

010623650 Special Topics in Materials Engineering II 3(3-0-6)

Prerequisite: None

Study in the interesting topics in materials engineering.

010623652 Welding Procedure Qualification for pressure vessel equipment 3(3-0-6)

Prerequisite: None

Preparation of welding procedure qualification documents for the pressure vessel equipment according to American Society of Mechanical Engineering (ASME) such as welding procedure specification (WPS), procedure qualification record (PQR), welding performance qualification (WPQ). Consisting of materials properties, welding process, general requirement of welding design, welding data, testing standard of welding specimen.

010623653 Welding Procedure Qualification for structure 3(3-0-6)

Prerequisite: None

Preparation of welding procedure qualification documents for the steel structure or non-pressure vessel equipment according to American Welding Society (AWS) such as welding procedure specification (WPS), procedure qualification record (PQR), welding qualification test (WQT), Consisting of materials properties, pre-heat and post-heat, general requirement of welding design, welding data, testing standard of welding specimen, testing standard of welding specimen.

010613601 Manufacturing Automation 3(3-0-6)

Prerequisite: None

Automation manufacturing system in industry. Principles and functions of automation devices, e.g. power units, pneumatic systems, hydraulic systems, sensors, machine automation control systems in industrial plants and computer applications in automation systems.

010613602 Computer aided Design 3(3-0-6)

Prerequisite: None

Principals of computer aided design to create three-dimensional modeling based on any of the modeling technique, i.e. solid modeling, surface modeling and shell modeling; geometric constraint; sketching, dimensioning and editing; Creation of orthogonal projection, perspective, two- and three-dimensional drawings on the computer.

010613603 Quality Control and Management 3(3-0-6)

Prerequisite: 040503011 Statistic for engineers and scientists

Meaning and importance of quality. Techniques and methods used by the organization to achieve the quality required by customers. Management and statistical operation of quality control practiced in production and service industries. Quality system. Quality management system. Planning and implementation of the quality control system. Quality assurance. Application of the quality control and management for materials engineering.

010613604 Engineering Economy 3(3-0-6)

Prerequisite: None

Principles and application of time-varying values of money and interest. Decision to select a proposal under different conditions. Selection of project by present worth analysis, annual worth analysis, and internal rate of return analysis. Calculation of depreciation. Replacement analysis. Break even point analysis. Economic sensitivity analysis. Applications of engineering economy for materials engineering.

010613605 Tools Engineering 3(3-0-6)

Prerequisite: None

The basic principles in metal cutting; Characteristics of metal cutting machine and tools, including the fixture system during operation of a cutting tool, and the various styles in using the cutting tool; Cutting force; The temperature of a cutting tool and metal scraps as well as characteristics of metal scraps; Wear and corrosion of a cutting tool; The resolution and measurement of the surface; Lubrication and cooling of cutting tools and proper usage of lubricants or coolants.

010613606 Industrial Plant Design 3(3-0-6)

Prerequisite: None

The type of equipment in materials handling and transportation in the factory; Factory system management, such as light, color and sound; Arrangement of equipment and tools economically and effectively; Directions of movement of materials in the factory and method of layout design for industrial plants.

010613607 Production Planning and Control 3(3-0-6)

Prerequisite: None

The production planning system in the continuous production process by using the techniques of forecasting demand of goods; Inventory control planning and planning for production; The project planning by arrangement of an effective job list; The case study of the modern factory production planning.

010613608 Strategic Engineering Management 3(3-0-6)

Pre-requisite : None

Competitive strategy and advantage. Red- and Blue-ocean strategy. Strategic Business Planning. Balanced score card. Strategy map. Implementation of the strategy. Case studies on the strategic management in engineering corporate and for the entrepreneur.

040113061 Chemistry for Engineers 3(3-0-6)

Prerequisite: None

Matters and scientific measurement, atoms molecules and ions, stoichiometry, electronic structure of the atoms, periodic properties, chemical bond, shape of molecules, gas liquid and solid, thermodynamics, chemical kinetics, chemical equilibrium, acid-base equilibrium, electrochemistry.

040113062 Chemistry Laboratory for Engineers 1(0-3-1)

Prerequisite: 040113061 Chemistry for Engineers (or co-requisite)

All experiments are corresponded to the course of 040113001 Chemistry for Engineers.

010123801 Computer in Everyday Life 3(3-0-6)

Prerequisite: None

The usage of package programs, word processing, spreadsheets; Familiarization with computer; The usage of operating systems, Windows and Unix; Usage of internet and management of internet security, morals, safety in health and quality of life; Basic programming and careers related to computers.

040113065 Chemistry in Everyday Life 3(3-0-6)

Prerequisite: None

Ingredients and properties of chemical products in everyday life such as soap, toothpaste, detergent, food additives, milk and its products, cosmetic products, paper, adhesives, cement, medicine, and agricultural chemicals, proper uses of chemical products and proper first-aid treatment due to chemical exposure.

040203110 General Mathematics 3(3-0-6)

Prerequisite: None

Mathematical structure, inductive and deductive reasoning, arguments and their validity, rectangular and polar coordinate systems, elementary functions, rates of change and derivatives, sequences and series, introduction to graph theory, mathematics of finance, applications of selected topics.

040203151 Engineering Mathematics and Computation I 3(3-0-6)

Prerequisite: None

Mathematical induction; sequences and series of numbers; limit, continuity. Differentiation of real-valued functions of a real variable, Taylor series expansions of elementary functions, their applications; indeterminate forms. Integration of real-valued functions of a real variable and their applications; techniques of integration; improper integrals. Applications of derivative. Mathematical problem solving using appropriate software packages.

040203152 Engineering Mathematics and Computation II 3(3-0-6)

Prerequisite: 040203151 Engineering Mathematics and Computation I

Calculus of real-valued functions of two variables, calculus of real-valued functions of several variables and their applications. Lines, planes, and surfaces in three-dimensional space; Polar coordinates. Vector algebra in three dimensions; differentiation and integration of vector-valued functions and their applications. Introduction to line integrals. Mathematical problem solving using appropriate software packages.

040313005 Physics I 3(3-0-6)

Prerequisite: None

Vector, Mechanics of motions, Newton's law of motion, Motion along a straight line, Circular motion, Simple harmonics motion, Superposition of two simple harmonics, Damped oscillation, Forced oscillation, Types of waves, Standing waves, shock waves, Beats, Intensity and sound level, Doppler effect, Moment of inertia, Equations of rotational motion, Torque, Angular momentum, Rolling, Precession of a gyroscope, Properties of materials, Heat transfer, Ideal gas equation, Laws of Thermodynamics, Heat engines and reverse engine, Physical properties of Fluid, Buoyancy, Pascal's law, Equation of continuity, Bernoulli's equation, Pressure measurement, Flow measurement.

040313006 Physics Laboratory I 1(0-2-1)

Prerequisite: 040313005 Physics I (or co-requisite)

This laboratory is related to the class 040313005 Physics I.

040313007 Physics II 3(3-0-6)

Prerequisite: 040313005 Physics I

Properties of waves, Reflection, Interference, Diffraction, Geometrical optics, Optical instruments, Coulomb's law, Electric fields, Gauss's law, Electric potential. Dielectric, Capacitor, Magnetic fields, Lorentz's force, Biot-savart's law, Ampere's law, Electromotive force, Inductor, Magnetic materials, Alternating, X-rays, Hydrogen atom, Duality, Many electrons atoms, band theory, Structure of nucleus, Radioactivity, Nuclear reactions.

040313008 Physics Laboratory II 1(0-2-1)

Prerequisite: 040313007 Physics II (or co-requisite)

This laboratory is related to the class 040313007 Physics II.

040503001 Statistics in Everyday Life 3(3-0-6)

Prerequisite: None

Overview statistics in everyday life. Problem solving systems using statistically logical skill. The uses of statistics in social science, humanity, government, sport, education, advertisement, finance, epidemiology, or others.

040503011 Statistics for Engineers and Scientists 3(3-0-6)

Prerequisite: None

Fundamentals of statistic, sample space and probability; sampling variables and probability function; expectation values, deviations and variants; discontinuous and continuous sampling variables, statistic induction: estimation and statistic experimentation of hypothesis; variant analysis; fundamental regression and correlation analysis. Engineering and scientific problem-solving using appropriate statistical software packages.

080103001 English I 3(3-0-6)

Prerequisite: None

Integrated skills of listening, speaking, reading, and writing at basic level in order to apply in daily life with the cultural awareness of diverse users. Learning vocabulary and grammatical structures through conversations, academic and general journals. Writing non-complex sentences and paragraphs. Extensive practice at Self-Access Learning Center (SALC) and through e-Learning.

080103002 English II 3(3-0-6)

Prerequisite: 080103001 English I

Integrated skills of listening, speaking, reading, and writing at basic level in order to apply in daily life with the cultural awareness of diverse users. Learning vocabulary and grammatical structures through conversations, academic and general journals. Writing complex sentences and paragraphs. Extensive practice at Self-Access Learning Center (SALC) and through e-Learning to promote life-long learning.

080103012 Reading I 3(3-0-6)

Prerequisite: 080103002 English II

Strategic reading, e.g. reading by scanning, reading by seeking specific information, guessing meaning from contexts or clues in order to derive the perception; improving reading skills from activities and exercises in the class.

080103016 English Conversation I 3(3-0-6)

Prerequisite: 080103002 English II

Fundamental skill in pronunciation and speaking skill for communication in daily life. Self introduction, describing things, and expressing opinions.

080103017 English Conversation II 3(3-0-6)

Prerequisite: 080103016 English Conversation I

Pronunciation and speaking skill with complex sentences in both prepared and impromptu situations. English communication skills in daily life with an emphasis on speaking and listening.

080103018 English for Work 3(3-0-6)

Prerequisite: 080103002 English II

Language skills for work, writing job applications, simple business letters, memos and minutes. Job interviews, making appointments, welcoming visitors, negotiations, describing job positions and products. Writing, presenting, and assessing projects.

080203901 Man and Society 3(3-0-6)

Prerequisite: None

Human beings settles and co-exists as a society. General features of human society. Organization of society, culture, and other social institutions. Social evolution and analysis of the problems of human society.

080203903 Social, Economics and Politics Dimension 3(3-0-6)

Prerequisite: None

Important characteristics of society, economics and politics. Development and change of society, social dimensions, ethics and living in dynamic society to sustainable development.

080203904 Law for Everyday Life 3(3-0-6)

Prerequisite: None

Characteristics and evolution of law, types of law, legal knowledge about life cycle in society and being good citizenship.

080203905 Economy and Everyday Life 3(3-0-6)

Prerequisite: None

Economics and the daily life of human; consumption, investment, inflation, deflation, financial institutions, taxation, economic circumstances; understanding the economic problems that occur and ways to fix the economic problems of government. Learning to adjust their lives upon the economic and social situation.

080203906 Business and Everyday Life 3(3-0-6)

Prerequisite: None

Basic ideas in business management, nature of business, environment, model, business ownership and problems in business

080303201 Effective Speech 3(3-0-6)

Prerequisite: None

The importance of speech; elements of speech; audience analysis and speech preparation; Psychological speech; Performing effective speech; Speech on an important occasion; Evaluation one own’s speech and other people’s speech.

080303501 Basketball 1(0-2-1)

Prerequisite: None

The history of basketball, techniques, rules, regulations, usage of proper equipment, practice in basic skills and applying the skills to play games, good sportsmanship and spectator.

080303502 Volleyball 1(0-2-1)

Prerequisite: None

The history of volleyball, techniques, rules, regulations, usage of proper equipment, practice in basic skills and applying the skills to play games, good sportsmanship and spectator.

080303503 Badminton 1(0-2-1)

Prerequisite: None

The history of badminton, techniques, rules, regulations, usage of proper equipment, practice in basic skills and applying the skills to play games, good sportsmanship and spectator.

080303504 Dancing 1(0-2-1)

Prerequisite: None

The history of social dance, fundamental techniques and manners, practice in basic skills of Latin dancing, ballroom dancing and so on. Arrangement of a social dance party.

080303505 Table Tennis 1(0-2-1)

Prerequisite: None

The history of table tennis, techniques, rules, regulations, usage of proper equipment, practice in basic skills and applying the skills to play games, good sportsmanship and spectator.

080303601 Human Relations 3(3-0-6)

Prerequisite: None

Principles and theories of human behavior, understanding one's self and others', self - development, communication, team working, leadership, conflicts and conflict management, society and culture, social etiquette, religious principles and application to enhance human relations.

080303605 Healthy Life 1(0-2-1)

Prerequisite: None

Nature of human body. Different types and styles of exercise that suit one's age and gender. Physical and mental balance. Using knowledge about the climate, food and water to balance the body and mind.

080303606 Systematic and Creative Thinking 3(3-0-6)

Prerequisite: None

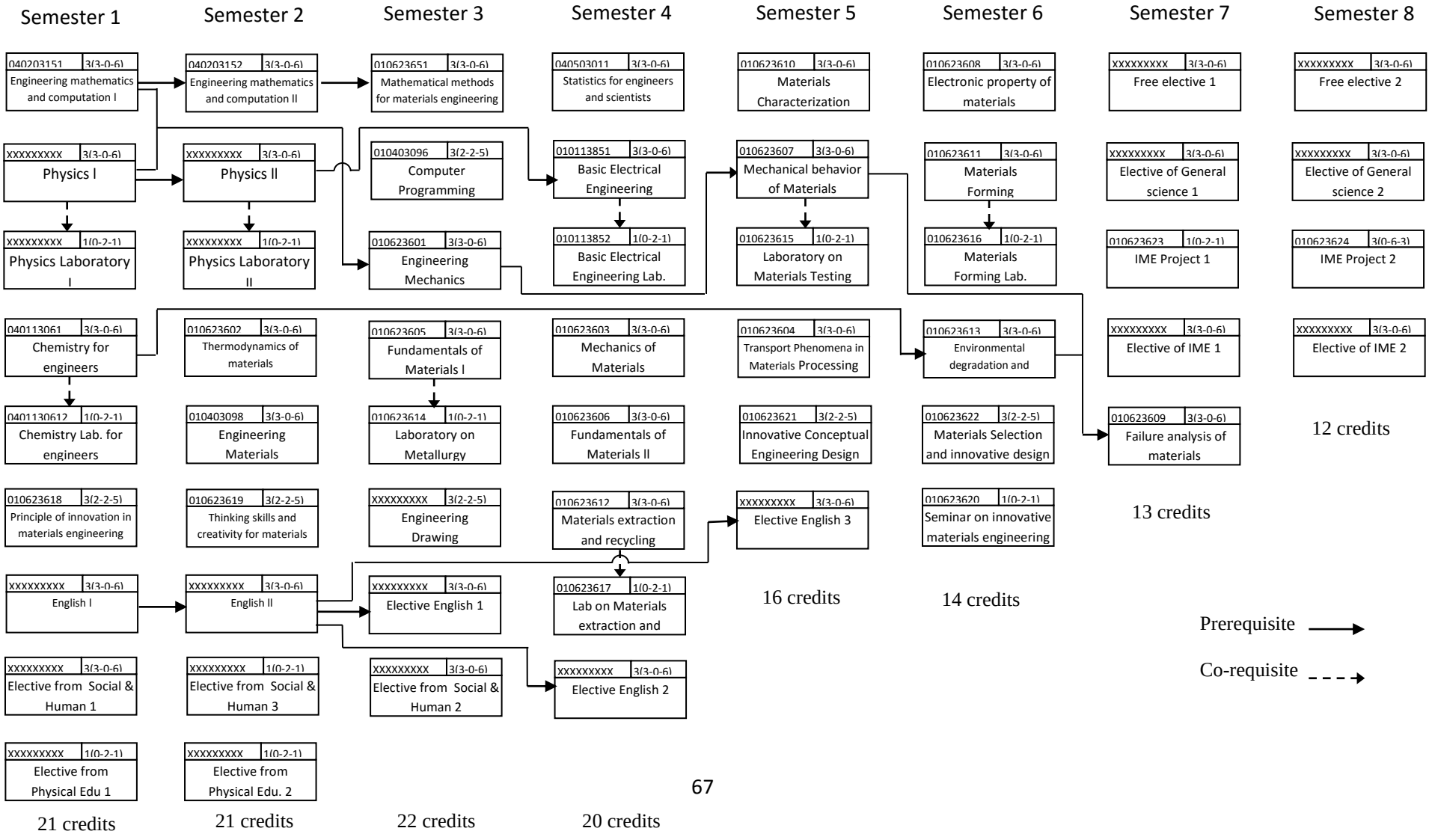
Basic brain function. The importance of thinking. Characteristics of the functions of left brain and right brain. Definition of systematic thinking. Features of systematic thinking. The techniques of systems thinking and the importance of creativity. Characteristics of individuals with creativity. The process of creativity and techniques of development and the application of creativity.

Industrial Training 0(0-240-0)

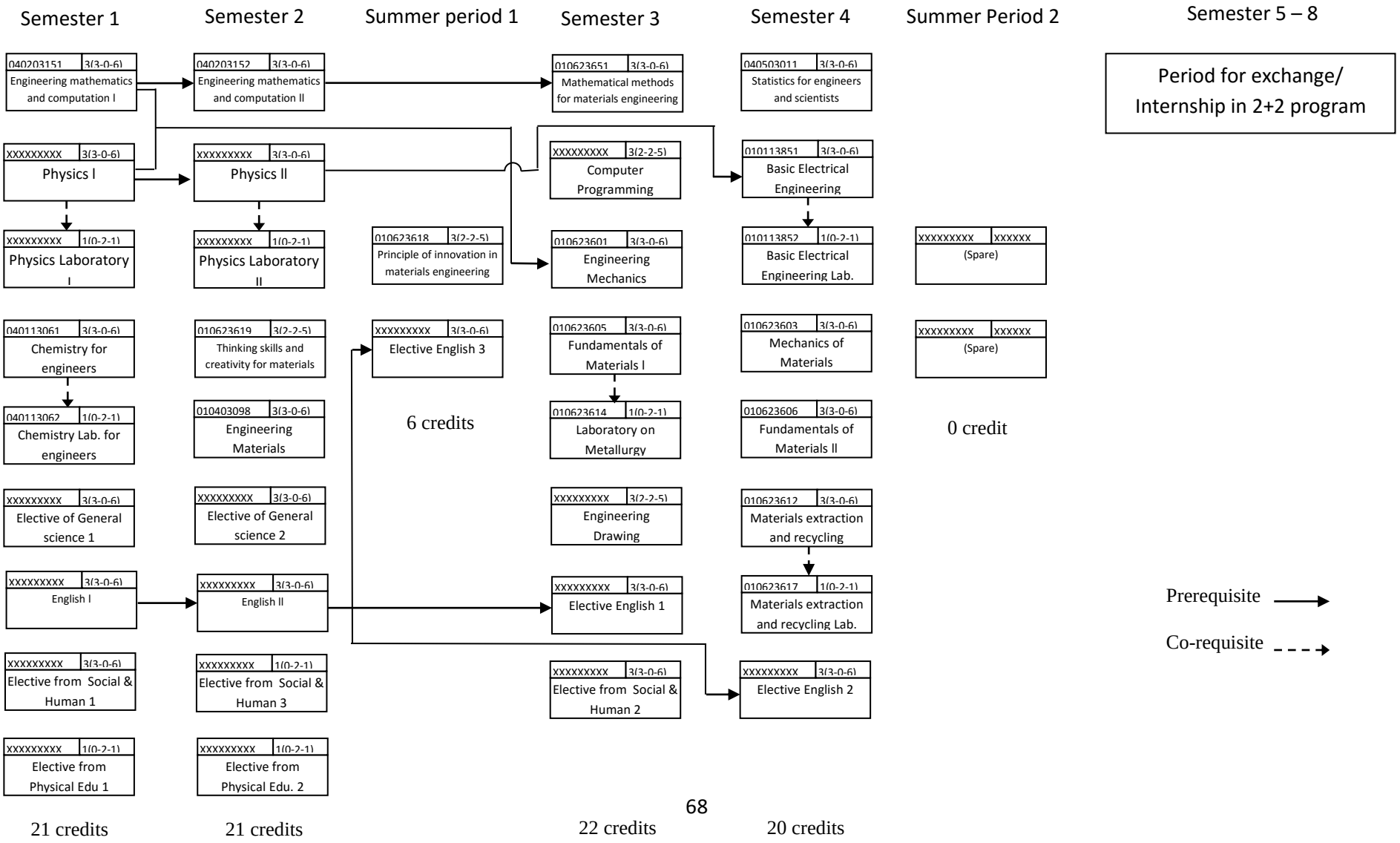
Prerequisite: None

Training in factory, engineering enterprises, public or private institutes which their works concern the engineering profession. Learning the case studies relevant to engineering in those organizations. Grading is S or U.

Appendix B **The flow chart of study in the bachelor engineering curriculum in Innovative Materials Engineering (International Program)**



The flow chart of study in the bachelor engineering curriculum in Innovative Materials Engineering (International with 2+2 program)



Guideline of the curriculum matching for the undergraduate courses in materials science and engineering between School of materials, University of Manchester, UK, and Department of materials and production engineering, faculty of engineering, KMUTNB, Thailand

This document is made to be the guideline of the compatibility of courses in materials science and engineering at University of Manchester and KMUTNB and to decide the qualification of students from KMUTNB who are going to attend the 2 + 2 program.

Firstly the description for the credit systems of both sides is described as the followings:

- University of Manchester: A typical course carrying 10 credits is expected to require 100 hours of attention by the student, including the formal contact time of 25 hours. And the time span of one semester takes 15 weeks. The contact time is varied in some cases.

- KMUTNB: A typical course which is counted for 3 credits is specifying 135 hours of attention by a student; this is including the lecture time of 45 hours. And the time span of one semester is the same as University of Manchester.

From the information above therefore the total study hours are taken as a basis to justify the equivalence of course units and credits. Then the 3 credits at KMUTNB are considered to be equivalent to 10 credits at University of Manchester. However, the course description and total study hours are also taken into account to show whether students of KMUTNB will qualify for 2 + 2 program. In the table 1 shows the matching courses between year 1 at University of Manchester and year 1 and 2 at KMUTNB. Furthermore the table 2 shows the matching courses of the later years.

At the appendix, there are the curriculum structure, the list of courses, 4 year study plan and course description of KMUTNB.

Table 1. Table of course units in Year 1 at University of Manchester and Year 1 and 2 at KMUTNB

School of materials		Depart. of materials and production engineering	
Course	Credit	Course	Credit
Year 1		Year 1, 2	
Materials Science I	20	Thermodynamics of Materials Fundamentals of Materials I Mechanics of Materials	3 3 3

Principle of Functional Materials	20	Engineering Materials	3
Mathematics 1G/2G	20	Engineering Mathematics and Computations I Engineering Mathematics and Computations II Mathematical Methods for Materials Engineering	3 3 3
Core Skills	20	Laboratory on Metallurgy Laboratory on Materials Extraction and Recycling Basic Electrical Engineering Electrical Laboratory	1 1 3 1
Materials Science II	20	Fundamentals of Materials II Materials Extraction and Recycling	3 3
Principles and Structural Materials	20	Principle of Innovation in Materials Engineering Thinking-skills and Creativity Development for Materials Innovators	3 3

-	-	Chemistry for Engineers Chemistry Laboratory for Engineers Physics I Physics Laboratory I Physics II Physics Laboratory II English I English II Language Elective Course 1 Language Elective Course 2 Computer Programming Engineering Drawing Statistic for Engineers and Scientists	3 1 3 1 3 1 3 3 3 3 3 3 3

The table 2 is showing the courses of school of materials of University of Manchester and KMUTNB with the matching score between both courses. Due to the diversity of expertise in materials science and engineering, matching between both sides is not as good as the former parts of both curricula. KMUTNB is mainly directed to metallurgy and polymer, while the University of Manchester is well providing wide spectra of courses in materials. However this problem is not going to affect students who are going to attend the 2 + 2 program because the matching of the former parts of both curricula is quite well.

Table 2 Table of course units in Year 2 and 3 at University of Manchester and Year 3 and 4 at KMUTNB

School of materials		Depart. of materials and production engineering	
Course	Credit	Course	credit
Year 2		Year 3	
Fundamental of Materials Science	20	Transport Phenomena in Materials Processing Seminar on Innovative Materials Engineering	3 1
Mechanics and Micromechanics	20	Mechanical Behaviour of Materials Laboratory on Materials Testing	3 1
Characterisation and Materials Physics	20	Materials Characterisation	3
Design, Management and Team Project	20	Innovative Conceptual Engineering Design	3
Fundamental of Materials Engineering	20	Environmental Degradation and Durability of Materials Materials Forming Laboratory on Materials Forming	3 3 1
Functional Materials	20	Electronic Property of Materials	3
(No Matching)		Language Elective Course 3 Physical Education Elective Course 1 Physical Education Elective Course 2 Social and humanities Elective Course 1	3 1 1

			3
Year 3		Year 4	
Structural Application in Materials Science	20	(As a Technical or Free Elective)	3
Advanced Functional Materials	20	(As a Technical or Free Elective)	3
Third Year Project	40	IME project I IME project II	1 3
Advanced Processing Materials	10	(As a Technical or Free Elective)	3
Materials Characterisation and Simulation	10	(As a Technical or Free Elective)	3
Performance of Materials in Service	10	Failure Analysis of Materials	3
Energy Materials	10	(As a Technical or Free Elective)	3
Advanced Structural Materials	10	(As a Technical or Free Elective)	3
Nanomaterials	10	(As a Technical or Free Elective)	3

Appendix C

The standardized map of the distribution of the learning outcomes from courses in the curriculum (Curriculum Mapping)

● **main responsibility** ○ **associate responsibility**

Courses	1. Morals and ethics					2. Knowledge					3. Cognitive skills					4. Interpersonal skills and responsibility					5. Numerical analysis skill, communication and information technology					6. Innovative skills				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
General education																														
a. Linguistic subjects																														
080103001 English I 3(3-0-6)	○	●	○	●		●			○	○			○		○	○	○								●					
080103002 English II 3(3-0-6)		●		●	●	●			●	●	●	●	●		●	●	●	●					●	●	●					
080103012 Reading I 3(3-0-6)	●	●	●	●	●	●	●	●	●	○	●	●	●	●	○	●	●	○	○	○	○	○	○	○	○					
080103016 English conversation I 3(3-0-6)		○		○	●				○				○		○	○	○								●					
080103016 English conversation II 3(3-0-6)		○		○	●				○				○		○	○	○	○							●					
080103018 English for work 3(3-0-6)			○	●		●		○	●	○		○	●	○	●	●	●	○				○	○		●					
b. Social and humanities subjects																														
080203901 Man and Society (3-0-6)	●	●	●	●	●	●	●			●	●		●		●	●	●	●	●	○		●	○	○	●					
080203903 Social, Economics and Politics Dimension 3(3-0-6)	●	●	○	●	●	●	○		○	●		●	●	○	●		●	●	○	○	○	○								
080203904 Law for Everyday Life 3(3-0-6)	●	●	●	●	●	●	○		●	●	●		○	○	●	●	●	○	●			○	○		○					
080203905 Economy and everyday Life 3(3-0-6)	●	●	●	●	●	●	●		○	●	●		●	○	●	●	○	○	○	●	●	●	○	○	○					

Courses	1. Morals and ethics					2. Knowledge					3. Cognitive skills					4. Interpersonal skills and responsibility					5. Numerical analysis skill, communication and information technology					6. Innovative skills				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
080203906 Business and Everyday Life 3(3-0-6)	●	●	●	●	●	●	○			○	●		●	○	●	●	●	○	●	○	●	●			○					
080303201 Effective Speech 3(3-0-6)	●		○	○		●			●		○				●	○	○					●		○	●					
080303601 Human Relations 3(3-0-6)	●	○	●	●	○	●			●		●		○		●	●	●	●				○	○	●	●					
080303605 Healthy Life 1(0-2-1)	●	○		○		●			●		○				●	●									●					
080303606 Systematic and Creative Thinking 3(3-0-6)			○	○	○	●	●		●	●	●	●	●	●	●	●	●			●	○	●			●					
c. Science and Mathematics																														
010123801 Computer in Everyday Life 3(3-0-6)	○		○	●		○		○				●			○	○		○		○			○	○						
040113005 Chemistry in Everyday Life 3(3-0-6)				●		●		●			●					●							○							
040203110 General Mathematics 3(3-0-6)	○	○	○	○	○	●	●	○		○		○	●	●	●	○	○	○	○	○	●	●	○	○	○					
040503001 Statistics in Everyday Life 3(3-0-6)		○		○		●	○		○	○	●	●		○		●					●	●	●	●	○					
d. Physical education																														
080303501 Basketball 1(0-2-1)	●	○		○		○			●						●	●	○									○					
080303502 Volleyball 1(0-2-1)	●	○		○		○			●						●	●	○									○					
080303503 Badminton 1(0-2-1)	●	○		○		○			●						●	●	○									○					
080303504 Dancing 1(0-2-1)	●	○		○		○			●						●	●	○									○					
080303505 Table Tennis 1(0-2-1)	●	○		○		○			●						●	●	○									○					

Courses	1. Morals and ethics					2. Knowledge					3. Cognitive skills					4. Interpersonal skills and responsibility					5. Numerical analysis skill, communication and information technology					6. Innovative skills				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Engineering education																														
a. Science Courses for engineering																														
040113061 Chemistry for Engineers 3(3-0-6)				●		●					●					●					○									
040113062 Chemistry Laboratory for Engineers 3(3-0-6)				●	○	●					●					●	●				○									
040203151 Engineering Mathematics and computation I 3(3-0-6)		○		○	○	●	●		○	○	○	○	○		○	○			○		○	○	○							
040203152 Engineering Mathematics and computation II 3(3-0-6)		○		○	○	●	●		○	○	○	○	○		○	○			○		○	○	○							
010623651 Mathematical Methods for Materials Engineering 3(3-0-6)		●		○	○	●	●	●	●	●	○	○	●		●	●	○	●	○	○	●	●	○		●	●	○	●		●
040313005 Physics I 3(3-0-6)	○	●	○	○	○	●	○	○	○	●	●	●	○	○		○	○	●	○	○	○	●	●	○						
040313006 Physics Laboratory I 1(0-2-1)	○	●	○	○	○	●	○	○	○	●	●	●	○	○		○	○	●	○	○	○	●	●	○						
040313007 Physics II 3(3-0-6)	○	●	○	○	○	●	○	○	○	●	●	●	●	○		○	○	○	●	○	○	●	●	○						
040313008 Physics Laboratory II 1(0-2-1)	○	●	○	○	●	●	○	○	●	●	●	●	●	○		○	○	○	●	○	○	●	●	○						
040503011 Statistics for Engineers and Scientists 3(3-0-6)		○		○		●	○		○	○	●	●		○		●					●	●	●	●	○					
b. Engineering Courses																														
010113851 Basic Electrical Engineering 1(0-3-1)		○				●							○					○						○						
010113852 Basic Electrical Laboratory 3(3-0-6)		●				○							○						○					○						
010403099 Engineering Drawing 3(2-2-5)	○	●	●	○	○	●	●	●	●	●	●	●	●	●	●	○	●	●	●	○	●	○	●	●	●					
010403098 Engineering Materials 3(3-0-6)	●	○	○	○	●	●	●	●	●	●	●	○	○	●	○	○	○	○	○	○	●	●	○	○	●					

Courses	1. Morals and ethics					2. Knowledge					3. Cognitive skills					4. Interpersonal skills and responsibility					5. Numerical analysis skill, communication and information technology					6. Innovative skills				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
010623601 Engineering Mechanics 3(3-0-6)	○	●	●	○	●	●	●	●	●	●	●	●	●	●	●	○	●	●	●	○	●	○	●	●	●	●	○			
010403096 Computer Programming 3(2-2-5)		●				●							○					○			●					●	○	●		○
010623602 Thermodynamics of Materials 3(3-0-6)		●				●	○	●	●	●	●	●	●	●		○		●	●	●	○	●	○	●	●	●	○			
010623603 Mechanics of Materials 3(3-0-6)		●	○	●	●	●	●	●	●	●		●	●	○	○	○	●	○	○	●		○		○	○	●	○			
010623604 Transport Phenomena in Materials Processing 3(3-0-6)		○				●	○	○	○	●	○	●	●	○	○	○		●	●	●	○	●	○	●		●	○			
c. Professional Core Courses																														
010623605 Fundamentals of materials I 3(3-0-6)		●	●		○	○	●		●	●	●	●	●	●	●	●	●	●	●		○	○	○	○		●	○			○
010623606 Fundamentals of materials II 3(3-0-6)		●	○	●	○	●	●	●	○	●		○	●		○	●	●	●	●	●				○	●	●	○		●	○
010623607 Mechanical behavior of materials 3(3-0-6)				●		●	●	○	○	●	●	●	●	○	●	○		○		●		●		●	●	●	○	●		
010623608 Electronic properties of materials 3(3-0-6)	●	●	●	○			●	●		●	●		●	●	●	●	●	●		○		○	○		○	●	○			○
010623609 Failure Analysis of Materials 3(3-0-6)		●	●	●	●	●	●	●	●	●	○	●	●	●	●	○	●	●	●	●		●		○	●	●	○			○
010623610 Materials Characterization 3(3-0-6)	●	●			○	○	○		●	●	●	●	●	●	●	○					●	○	●	●	●	●	○			
010623611 Materials Forming 3(3-0-6)		○			○	●	●	●	○	●	○	●	●		○	○	○	○	○	○		○		●	○	●	○			
010623612 Materials extraction and recycling 3(3-0-6)		●	○			●	●	●	●	●	●	●	●	●	●	●	●	●	●		○	○	○	○	○	●	○			
010623613 Environmental degradation and durability of materials 3(3-0-6)		●				●	○	●	●	●	●	●	●	●	●	○	○	○	○		●	●	○	●	●	●	●	●	○	○
010623614 Laboratory on Metallurgy 3(3-0-6)		●				●	○	●	●	●	●	●	●	●	●	○	○	○	○	○	●	●	○	●	●	○	●	●	●	●

Courses	1. Morals and ethics					2. Knowledge					3. Cognitive skills					4. Interpersonal skills and responsibility					5. Numerical analysis skill, communication and information technology					6. Innovative skills				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
010623615 Laboratory on Materials Testing 3(3-06)		●	○			●	●	○	●	○	●	●	○	●	●	○	●	○	●		●	●	○	○	●	○	●	●	●	●
010623616 Laboratory on Materials Forming 1(0-2-1)		●	●			●	●	○	○	○	○	●	●	○	○	○	○	○	●	●	●	●	○	●		○	●	●	●	●
010623617 Laboratory on Materials extraction and recycling 1(0-2-1)		●	●			●	●	○	○	○	○	●	●	○	○	○	○	○	●	●	●	●	○	●		○	●	●	●	●
d. Innovative Materials Engineering																														
010623618 Principle of innovation in materials engineering 3(2-2-5)		●	●					○	●		●	●	●	●	●	●	●				○	○	○	○		●			●	●
010623619 Thinking skills and creativity for materials innovators 3(2-2-5)		●	●					○	●	●	●	●	●	●	●	●	●	○	○		○	○	○	○		●	○		●	●
010623620 Seminar on Innovative Materials Engineering 1(0-2-1)		●	●		○	○	●		●	●	●	●	●	●	●	●	●	●	●		○	○	○	○		●	○		●	○
010623621 Innovative conceptual engineering design 3(2-2-5)		●	●	●	○	●	●	●	●	●	○	●	●	○	●	○	●	●	●	○	○	○	○	○	○	●	●	●	●	●
010623622 Materials selection and innovative design 3(2-2-5)		●	●	●	○	●	●	●	●	●	○	●	●	○	●	○	●	●	●	○	○	○	○	○	○	○	○	○	●	●
010623623 Innovative Materials Engineering Project I 1(0-2-1)	○	●	●	●	○	●	●	●	●	●	○	●	●	○	●	○	●	●	●	○	○	○	○	○	○	●	●	●	●	●
010623624 Innovative Materials Engineering Project II 3(0-6-3)	○	●	●	●	○	●	●	●	●	●	○	●	●	○	●	○	●	●	●	○	○	○	○	○	○	●	●	●	●	●
e. Elective topics in materials engineering																														
010623625 Phase Transformation 3(3-0-6)		●	●		●		●	●				●	●			●	○	●	○		●	●	○	●	●	●	○			○
010623626 Surface Engineering 3(3-0-6)		●	●		●		●	●				●	●			●	○	●	○		●	●	○	●	●	●	○			○
010623627 Non-Destructive Testing 3(3-0-6)		○		○	○	○	●	○		○	○	○	●	○	○	○			○	●	●	●	○	○	●	●	○			○
010623628 Tribology 3(3-0-6)		●	●		●		●	●				●	●			●	○	●	○			●		●	●	●	○			○

Courses	1. Morals and ethics					2. Knowledge					3. Cognitive skills					4. Interpersonal skills and responsibility					5. Numerical analysis skill, communication and information technology					6. Innovative skills				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
010623629 Safety in Materials Engineering 3(3-0-6)	●	●					●	●		●		●	●					●	●		●	●				●	○			○
010623630 Energy and Environment in Materials Engineering 3(3-0-6)		●	●		○	○	●		●	●	●	●	●	●	●	●	●	●	●		○	○	○	○		●	○			○
010623631 Metallurgy and thermal processing 3(3-0-6)																														
010623632 Metallurgy and thermal processing laboratory 1(0-2-1)																														
010623633 Foundry technology 3(3-0-6)		●	●		●		●	●				●	●			●	○	●	○		●	○	○	●	○	●	○			○
010623634 Foundry technology laboratory 1(0-2-1)	●	○			●	●	○	●	○	●	●	○	●	●	○	●	○	●		●	●	○	○	●		●	○			○
010623635 Welding Metallurgy 3(3-0-6)		●				●	○	●	●	●	●	●	●	●	●	●	○	●	○		○	○	○	●	○	●	○			○
010623636 Heat Treatment of metals 3(3-0-6)		●	●		●		●	●				●	●			●	○	●	○			○	○	●	○	●	○			○
010623637 Laboratory on Heat Treatment of metals 1(0-2-1)	●	○			●	●	○	●	○	●	●	○	●	●	○	●	○	●		●	●	○	○	●		●	○			○
010623638 Powder Metallurgy 3(3-0-6)		●	●		●		●	●				●	●			●	○	●	○							●	○			○
010623639 Stainless Steels 3(3-0-6)		●				●	●	●	●	●	●	●	●	●	●	○	○	○	○				○	○	●	●	○			○
010623640 High-Temperature Materials 3(3-0-6)		●				●	●	●	●	●	●	●	●	●	●	○	○	○	○		●		○	○	●	●	○			○
010623641 Aluminium Processing Technology 3(3-0-6)		●	●		●		●	●				●	●			●	○	●	○				○	○	●	●	○			○
010623642 High Temperature Corrosion and Protection of Metals 3(3-0-6)		●	●		○	●	●		●	●		●	●		●	○	●	●	●	●			○	○	●	●	○			○
010623643 Micro and nano electromechanical systems 3(3-0-6)		●	○			●	●	○			○	○	●		○	○	○	○		○	○	○		○		●	○		○	●

Courses	1. Morals and ethics					2. Knowledge					3. Cognitive skills					4. Interpersonal skills and responsibility					5. Numerical analysis skill, communication and information technology					6. Innovative skills				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
010623644 Introduction to nanotechnology for materials engineering 3(3-0-6)		●	●		●		●	●				●	●			●	○	●	○		○		○	○		●	○			○
010623645 Polymer Colloids 3(3-0-6)		●	○				●	○		○	●	●	○		●	○	●	○	●		○		○	○		●	○			○
010623646 Polymer Processing and rheology 3(3-0-6)	●	●	●				●	●		●	●		●	●	●	●	●	●		○		○	○		●	●	○	○	●	○
010623647 Fracture mechanics of materials 3(3-0-6)		●				●	○	●	●	●	●	●	●	●		○		○			○	○	○	○	○		●			
010623648 Biocompatible Materials 3(3-0-6)																														
010623649 Special Topic in Innovative Materials Engineering I 3(3-0-6)		○			○	●	●	●	○	●	○	●	●		○	○	○	○	○	○		○		●	○	●	○			○
010623650 Special Topic in Innovative Materials Engineering II 3(3-0-6)		○			○	●	●	●	○	●	○	●	●		○	○	○	○	○	○		○		●	○	●	○			○
010613601 Manufacturing Automation 3(3-0-6)		●	●		●		●	●				●	●	○	○	●	○	●	○		●	●	○	●	●	●	●		○	○
010613602 Computer-aided design (2-2-5)	○	●	●	○	○	●	●	●	●	●	●	●	●	●	●	○	●	●	●	○	●	○	●	●	●	●	●	●	○	
010613603 Quality Control and Management 3(3-0-6)	●	●					●	●		●		●	●					●	●		●	●				●	○			○
010613604 Engineering Economy 3(3-0-6)	●	●					●	●		●		●	●					●	●		●	●				●	○			○
010613605 Tools Engineering 3(3-0-6)	●	●					●	●		●		●	●					●	●		●	●				●	○			○
010613606 Industrial Plant Design 3(3-0-6)	●	●					●	●		●		●	●					●	●		●	●				●	○			○
010613607 Production Planning and Control 3(3-0-6)	●	●					●	●		●		●	●					●	●		●	●				●	○			○
010613608 Strategic Engineering Management 3(3-0-6)	●	●					●	●		●		●	●					●	●		●	●				●	○			○

Courses	1. Morals and ethics					2. Knowledge					3. Cognitive skills					4. Interpersonal skills and responsibility					5. Numerical analysis skill, communication and information technology					6. Innovative skills				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
xxxxxxxxx Value Engineering 3(3-0-6)	●	●					●	●		●		●	●					●	●		●	●				●	○			○
xxxxxxxxx Strategic Engineering Management 3(3-0-6)		●	○			●	●	○			○	○	●		○	○	○	○		○	○	○		○		●	○			○
Industrial Training																														
010623201 Industrial Training 0(0-240-0)	○	●	●	●	○	●	●	●	●	●	○	●	●	○	●	○	●	●	●	○	○	○	○	○	○	●	●	●	●	●